September 13, 2022

City of Castle Pines

Contents

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Acronyms and Abbreviations

As used in these Roadway Standards, the following abbreviations shall apply:

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
°K	degree(s) Kelvin
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	*Americans with Disabilities Act*
ASTM	ASTM International
AWG	American Wire Gauge
BMP	best management practices
CCD	charge-coupled device
CDOT	Colorado Department of Transportation
City	City of Castle Pines
dB	decibel(s)
dB/km	decibel(s) per kilometer
dBm	decibel(s) per milliwatt
DC	direct current
EIA	Electronic Industries Alliance
ESAL	equivalent single axle load
GESC	grading, erosion, and sediment control
GPS	global positioning system
HCM	Highway Capacity Manual
HOA	Home Owner's Association
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IMSA	International Municipal Signal Association
IR	infrared
ISO	International Organization of Standardization
ITE	Institute of Transportation Engineers
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
kip	kilopound
lbf	pound-force
LOS	level of service

MHFD	Mile High Flood District
mm	millimeter(s)
mph	mile(s) per hour
M_R	Resilient Modulus
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
N	Newton(s)
NEC	National Electrical Code
No.	number
nm	nanometer(s)
O&M	operation and maintenance
OTDR	optical time domain reflectometer
OSD	on-screen display
PC	point of curve
PCC	point of compound curvatures
PCR	point of curb return
PI	plasticity index or point of intersection
PIA	Public Improvements Agreement
Professional Engineer	PE
psf	pound(s) per square foot
psi	pound(s) per square inch
PT	point of tangent
PVC	polyvinyl chloride or point of vertical curve
RCP	reinforced concrete pipe
Rules	Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission
RUS	United States Department of Agriculture Rural Utilities Service
SI	serviceability index
SIA	Subdivision Improvements Agreement
SIA-Private	Subdivision Improvements Agreement for Private Development
SIP	Site Improvement Plan
SIPIA	Site Improvement Plan Improvements Agreement
SN	Structural Number
SSN	Section Standard Number
Telecordia	Telcordia Technologies, Inc.
TIA	Telecommunications Industry Association
TIS	Traffic Impact Study

TL	turning line
TV	television
UPS	uninterruptable power source
USC&GS	United States Coast and Geodetic Survey
VAC	volt alternating current
VIP	video image processing

Chapter 1 - General Provisions

1.1 Short Title

These Regulations, together with all future amendments, shall be known as the "City of Castle Pines Roadway Design and Construction Standards" (hereinafter called Roadway Standards). The original Roadway Standards were adopted by the City Council on September 13, 2022.

1.2 Enactment Authority

The Regulations are adopted pursuant to the authority conferred within Section 11, Article 3, of the City's Municipal Code; Article 2 of Title 43 (State, County and City Highway Systems); Article 67 of Title 24 (Planned Unit Development Act); Article 20 of Title 29 (Land Use Control and Conservation); and other applicable sections of Colorado Revised Statutes, as amended. Pursuant to the above authority statutory, these Standards are adopted by ordinance and are incorporated by reference as a part of the Regulations.

1.3 Jurisdiction

These Roadway Standards shall apply to all land within the City, except where superseded by State of Colorado (Department of Transportation) jurisdiction. All roads, public or private, must conform to these standards, unless the Public Works Director accepts alternative standards. Refer to Chapters 2 and 7.

1.4 Purpose

Presented in these Roadway Standards are the minimum design and technical criteria for the analysis and design of roadway facilities and infrastructure. All subdivisions, re-subdivisions, planned developments, or any other proposed construction submitted for acceptance under the provisions of the City's Municipal Code, shall include adequate roadway system analysis and appropriate roadway system design. Such analysis and design shall conform to the criteria set forth herein. Options to the provisions of these Roadway Standards may be proposed by the Applicant. It shall be the responsibility of the Applicant to demonstrate that the options meet or exceed the minimum criteria contained herein. Policies and technical criteria not specifically addressed in this document shall follow the provisions of the American Association of State Highway and Transportation Officials "A Policy on Geometric Design of Highways and Streets," (hereinafter called the Green Book or AASHTO) as amended; the Colorado Department of Transportation (CDOT) Design Standards and Construction Standards, as amended; the CDOT Access Code, as amended; and the Manual on Uniform Traffic Control Devices (MUTCD), as amended

1.5 Amendment and Revisions

The standards and criteria may be amended as new technology is developed or experiences are gained in the use of these Roadway Standards, which indicate a need for revision. The City Council will consider revisions or amendments to these Roadway Standards following the recommendations of the Public Works Director. Accepted revisions will be adopted by resolution following a public hearing thereon. The Public Works Director shall monitor the performance and effectiveness of these Roadway Standards and will recommend changes, amendments, and revisions as necessary.

1.6 Enforcement Responsibility

It shall be the duty of the City Council, acting through the Public Works Director, to enforce the provisions of these Roadway Standards.

1.7 Review and Acceptance

The City will review all submittals for general compliance with these Roadway Standards. Once the City of Castle Pines has determined that plans are in general compliance with these Roadway Standards, and the Acceptance Block has been signed on all plan sheets, the plans will be considered Accepted. Acceptance by the City does not relieve the Owner, Engineer, or Designer from the responsibility of ensuring that the calculations, plans, specifications, construction, and Record Drawings are in compliance with these Roadway Standards as stated in the engineer's certification.

1.8 Interpretation

The interpretation and application of the provisions of these Roadway Standards shall govern as follows:

1) These provisions shall be regarded as the minimum requirements for the protection of the public health, safety, comfort, convenience, prosperity, and welfare of the public. These Roadway Standards shall therefore be regarded as remedial and shall be liberally construed to further its underlying purposes.
2) Whenever a provision of these Roadway Standards or any provision in any law, ordinance, resolution, rule, or regulation of any kind, contain any restrictions covering any of the same subject matter, whichever standards are more restrictive or impose higher standards or requirements shall govern.
3) These Roadway Standards shall not modify or alter any nonexpired road construction plans that have been filed with, and accepted by, the City prior to the effective date of this Resolution and future revisions. This exception shall be subject to the conditions and limitations under which said plans were accepted.

1.9 Variances

Variances from these Roadway Standards will be considered on a case-by-case basis in accordance with procedures outlined in Chapter 2.

Chapter 2 - Submittal Procedures and Requirements

2.1 Drawings and Specifications

2.1.1 Procedures and Requirements

Consulting engineers and developers seeking acceptance of civil engineering reports and construction documents shall follow the procedures outlined herein. Submittal procedures and requirements for the various City of Castle Pines (City) land development processes can be found in the City's Municipal Code and in other City publications. Initial submittal of reports or plans without fees shall constitute an incomplete submittal and will not be processed until receipt of fees. Additional fees may be required for resubmittals. Resubmittals are subject to the City of Castle Pines Fee Schedule. Additional fees may be added in the permitting process.

2.1.2 Pre-submittal Meetings

The City routinely conducts pre-submittal meetings at which Applicants to the various City land development processes may ask questions or obtain direction. These meetings are intended to supply basic information about City procedures, practices, or standards as a basis on which to begin development planning.

2.1.3 Construction Documents

The City may request, with the initial submittal to the City, two sets of construction documents. The submittal shall include detailed drawings for the entire project (refer to Section 2.3 Submittal Checklist).

2.1.4 Engineering Review Objective

The City's objective for new submittals is to complete initial reviews in timelines specific to Department or Permit type. The actual time required is a function of the submittal complexity and overall workload of City reviewers.

2.1.5 Results of Engineering Review

The review comments shall be forwarded to the Applicant's Representative. If plans lack adequate information or are considered seriously deficient, they will be returned to the Applicant's Representative without review.

2.1.6 Revision of Engineering Plans and Reports

The Applicant's Representative will make all revisions requested on their original plans or report and resubmit according to the review comments. As part of the revision process, the Applicant's Representative may contact the City reviewer to receive clarification or discuss comments. The City will normally process the resubmitted plans within 15 regular business days. Plans may require several reviews prior to acceptance.

1) When submitting revised plans, drawings, or reports to the City, the resubmittal must contain the following:
   a) A comment response letter from the Applicant's Representative outlining how each comment was addressed; this letter should include the results of any correspondence conducted with a City reviewer and the resolution.
   b) The revised plans and reports for review.
2) When plans or reports have been accepted by the City, the Applicant, if requested by the City, shall submit two sets to ten sets of the Construction Plans, signed and stamped by a Professional Engineer (PE) licensed in the State of Colorado, for signature. Two copies of all certified Engineering Reports shall be submitted. The City will keep two sets of the Construction Plans and all Reports.
3) The time needed to obtain signed Construction Plans from the City is 10 regular business days. This time may be extended depending on workload conditions. Resubmittals made more than 90 days after the date of the City-reviewed comment letter will be treated as a new submittal, and a new engineering review fee will be due unless an extension is requested by the Applicant and granted by the City in writing. If the Land Use Application has been closed by the City, any associated Construction Document resubmittal is considered a new application, and new engineering review fees will apply.

2.2 Revisions to Accepted Plans

2.2.1 Validity Period

Construction Plans, Pavement Design Reports, and other engineering documents that are accepted by the City are valid for a period of 2 years. If construction has not commenced during this time period, the plans and reports shall be voided and must be brought into conformance with current criteria and accepted by the City before any Permits can be issued. Contact the City with questions regarding Drainage Report time limits.

2.2.2 Updates and Revisions

When submitting updates or revisions to previously accepted Construction Plans, Pavement Design Reports, Traffic Impact Study Reports, Drainage Reports, and other documents, the Applicant shall revise the documents and submit updates or revisions through the normal document submittal process.

2.3 Submittal Checklist

The following documents may be included with any Construction Plan submittal:

1) Engineering Review Fee (first submittal only)
2) Cover Sheet
3) Street Plan and Profiles
4) Storm Sewer Plan and Profiles
5) Evidence showing upload of Grading, Erosion, and Sediment Control (GESC) documents to the standalone GESC Permit
6) Permanent Detention and Water Quality Facilities and associated appurtenances
7) Culvert Plan and Profiles
8) Traffic Signage and Striping Plan with City Standard Details and Notes

9) Standard City Details

10) Non-City Details (If used, these details must be signed and stamped by a PE licensed in the State of Colorado)

11) Traffic Control Plan (submitted with the Construction Plans at the discretion of the City)

12) Other plan sheets and documents as required

   a) Landscape

   b) Traffic Impact Study Report

   c) Pavement Design Report

   d) Water and sanitary sewer construction plans that have been accepted and approved by the governing district or utility (if these plans represent improvements for installation within a City right-of-way, they must be accepted by the City.)

   e) Other Utilities

   f) Phase III Drainage Report

   g) Applicable Improvements Agreement form with engineering cost estimate

   h) Final Plat with appropriate dedication statements for public right-of-way and easements

   i) Traffic Signal

   j) Lighting

2.4 Drafting Standards

All Construction Documents submitted for acceptance shall meet the following standards:

1) Plans size shall be 24 by 36 inches (or minimum 11 by 17 inches at the City's discretion).

2) Text height shall not be less than one-tenth (0.10) of an inch on a 24- by 36-inch plan set or less than one-five hundredths (0.05) of an inch on an 11- by 17-inch plan set.

3) Design text shall be black.

2.5 General Submittal Requirements for Construction Documents

The following documentation is required in conjunction with the submittal of construction plans for any roadway or storm drainage improvement project in Castle Pines. All Construction Plans and Engineering Reports shall be prepared by, or under the direct supervision of, a PE licensed in the State of Colorado, and shall be reviewed for the minimum requirements set forth herein. The City may require additional information and analysis beyond the minimum requirements of these Roadway Standards and criteria.

2.6 Cover Sheet

2.6.1 Cover Sheet Requirements

A Cover Sheet is required for every submittal. The Cover Sheet requirements are as follows:

1) Vicinity map

2) Sheet Index

3) Standard Notes

4) Acceptance Block
5) Engineering Certification Note
6) Title Block
7) Project Title
8) Project Contacts (City Representative, Engineer, Developer, and Owners' Representative, affected utilities at a minimum)
9) Benchmark and Basis of Bearing
10) Overall Key Map
11) Official Name of the Subdivision

2.6.2 Vicinity Map

1) Minimum scale is 1 inch = 2,000 feet. Map must show the location and name of all Arterial roadways and major drainageways within 1 mile of the proposed construction site, and all other roadways in the vicinity of the proposed construction site. Shading shall indicate the project area. Section, Township, and Range shall also be shown. North arrow and scale shall be included.
2) Minimum size of vicinity map shall be 6 inches by 6 inches.

2.6.3 Sheet Index

The Sheet Index shall be located along the right side of the sheet and should include all sheets in the construction plan set, numbered consecutively, beginning with the Cover Sheet. No letters shall be used for sheet numbers.

2.6.4 Standard Notes

The following Standard Notes shall be included on the Cover Sheet or a Standard Notes Sheet as applicable:

1) The City Development Review Engineer's signature affixed to this document indicates the City has reviewed the document and found it to generally conform with the City of Castle Pines Roadway Design and Construction Standards, applicable municipal code, and any associated agreement (such as a Development Agreement) or accepted variances to those Regulations. Through acceptance of this document, the City assumes no responsibility, other than stated previously, for the completeness and accuracy of these documents. The Owner and engineer understand that the responsibility for the engineering adequacy of the facilities depicted in this document lies solely with the PE registered in the State of Colorado whose stamp and signature are affixed to this document.
2) All construction shall conform to City Standards. Any construction not specifically addressed by these Roadway Standards and specifications will be built in compliance with the latest edition of the most stringent of the following:
    a) The City of Castle Pines Roadway Design and Construction Standards
    b) The Colorado Department of Highways Standard Specifications for Road and Bridge Construction
    c) The Colorado Department of Transportation (CDOT) M&S Standards
3) All materials and workmanship shall be subject to inspection by the City as applicable. The City reserves the right to accept or reject any such materials and workmanship that do not conform to its Standards and Specifications.

4) The contractor shall notify the City Public Works Department a minimum of 24 hours and a maximum of 72 hours prior to starting construction of elements that require review and inspection. Notification shall consist of the contractor's contacting the City Public Works Department and receipt of acknowledgement by the City. The Contractor shall notify the City when working outside of the public right-of-way on any facility that will be conveyed to the City, MHFD, or other special districts for maintenance (storm sewer, energy dissipaters, detention outlet structures, or other drainage infrastructures). Failure to notify the City to allow inspection of the construction may result in non-acceptance of the facility or infrastructure by the City, MHFD, or both.

5) Construction shall not begin until all applicable Permits have been issued. If a City Inspector is not available after proper notice of construction activity has been provided, the permittee may commence work in the Inspector's absence. However, the City reserves the right not to accept the improvement if subsequent testing reveals an improper installation.

6) The location of existing utilities shall be verified by the Contractor prior to actual construction.

7) The Contractor shall have one copy of the Plans signed by the City, one copy of the Roadway Design and Construction Standards, latest version, and all applicable Permits at the job site at all times.

8) All proposed street cuts to existing pavements for utilities, storm sewer, or for other purposes are listed and referenced here:

Examples:	Water tie-in	Sheet 3
	Storm sewer Connection	Sheet 6

9) A Traffic Control Plan, in accordance with the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), shall be submitted to the City for acceptance with the Right-of-Way Permit Application. A Right-of-Way Permit will not be issued without an accepted Traffic Control Plan for traffic control during construction. Exceptions can be made by the City Public Works Department if construction does not include traffic control .

10) The Construction Plans shall be considered valid for 2 years from the date of City acceptance, after which time, these plans shall be void and will be subject to re-review and re-acceptance by City.

11) City of Castle Pines Standard Details shall not be modified. Any non-standard details will be clearly identified as such.

12) Paving, including construction of curb and gutter (when used), shall not start until a Pavement Design Report and subgrade compaction tests are accepted by the City for all public and private roads.

13) Standard City Americans with Disabilities Act ramps are to be constructed at all curb returns and at mid-block locations opposite of one of the curb returns of all "T" intersections as identified on the plans.

14) All stationing is based on roadway centerlines unless otherwise noted.

15) All elevations are on United States Coast and Geodetic Survey (USC&GS) (NAVD 88) DATUM with date. The Range Point or Monuments shall be shown on construction drawings.

16) All storm sewer improvements (public and private), including, but not limited to, inlets, pipes, culverts, channels, ditches, hydraulic structures, riprap, detention basins, forebays, micro-pools, and water quality facilities, require permitting and inspections. Please contact the City Public Works Department for inspection scheduling.

17) Two manhole access points are required on all Type "R" curb inlets greater than or equal to 10 feet in length.

18) Epoxy-coated rebar is required on all drainage structures.

19) The City requires Class D concrete for all drainage structures.

20) All reinforced concrete pipe (RCP) storm sewers must use ASTM International (ASTM) C443 watertight gaskets per the current City and MHFD design criteria.

21) All RCP shall be Class III storm sewer pipe, unless otherwise specified.

22) Joint restraints are required for a minimum of the last two pipe joints and flared end section of an RCP outfall.

23) Toe walls are required on flared end sections at the outlet end of culverts and storm sewer outfalls.

24) Filter fabric is required under all riprap pads.

25) The PE registered in the State of Colorado who signs these plans is responsible for confirming that the details included are compatible with the standard City details contained in the latest versions of the criteria manuals. These include, but are not limited to, the following:

   a) City of Castle Pines Roadway Design and Construction Standards

   b) City of Castle Pines Storm Drainage Design and Technical Criteria

   c) City of Castle Pines Grading, Erosion and Sediment Control Criteria

   d) CDOT M&S Standards

   e) MUTCD

   f) MHFD Criteria Manual Volumes 1, 2, and 3

26) A Temporary Construction Access Permit from the City may be required for any project.

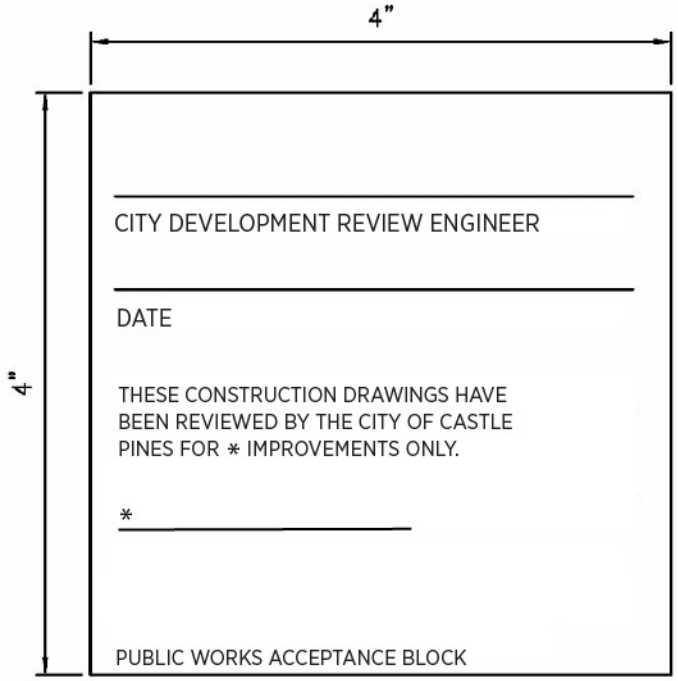
If roadways are to be dedicated on the Final Plat to an entity other than the City, then the following statement shall be included with the Standard Notes:

> "27. The City of Castle Pines shall not be responsible for the maintenance of roadway and appurtenant improvements, including sidewalk and storm drainage infrastructure, for the following private streets: (*List street names*)"

2.6.5 Acceptance Block

The Acceptance Block shall be located in the lower right-hand corner of each sheet, except for Castle Pines Standard Detail sheets. (Refer to Figure 2-1).

Figure 2-1. Acceptance Block



* Insert the applicable wording or combination of wording into the Acceptance Block:

1) Street and Drainage
2) Grading, Erosion, and Sediment Control
3) Landscaping within the Public Right-Of-Way
4) Utilities
5) Signage and Striping
6) Traffic Signal

2.6.6 Public Works Certification Note

Construction Plans and Engineering Reports submitted for review and comment shall be prepared by, or under the direct supervision of, a PE licensed in the State of Colorado. All sheets of the Construction Plans must be signed and stamped by a PE licensed in the State of Colorado, except the City of Castle Pines Standard Detail sheets. Construction Plans and Engineering Reports must include the following statement on the Cover Sheet:

> *"These Construction Plans for (name of subdivision, development, or project) were prepared by me (or under my direct supervision) in accordance with the requirements of the City's Roadway Design and Construction Standards, Storm Drainage Design and Technical Criteria, and the Grading, Erosion, and Sediment Control Manual."*
>
> *Name of Engineer*
> *Name of Firm*

On the Final Construction Plans and Engineering Reports submitted for acceptance, the statement shall be signed and stamped by the PE who prepared or supervised the preparation of the documents.

The City of Castle Pines, through the acceptance of the Construction Plans and Engineering Reports, assumes no responsibility for the completeness or accuracy of the Construction Plans or Engineering Reports.

2.6.7 Title Block

A Title Block is required on every sheet. The subdivision name and filing number; Land Use name (if applicable); the type of improvement; name, address (including zip code), and telephone number of the Applicant's representative; sheet number; and revision date and number shall be included in the Title Block.

The Title Block shall be located in the extreme lower-right-hand corner, the right-side margin, or along the bottom edge of the sheet (refer to Figure 2-2).

Figure 2-2. Title Block Layout

2.6.8 Project Title

The Project Title shall be centered on the top of the Cover Sheet.

2.6.9 Contacts for Project

The name, address (including zip code), telephone number, and email address of the Applicant's Engineer, Owner's Representative, Developer, City representative, and affected utilities shall be included at a minimum.

2.6.10 Benchmark and Basis of Bearing

The Benchmark shall be shown as USC&GS NAVD-88 DATUM with date.

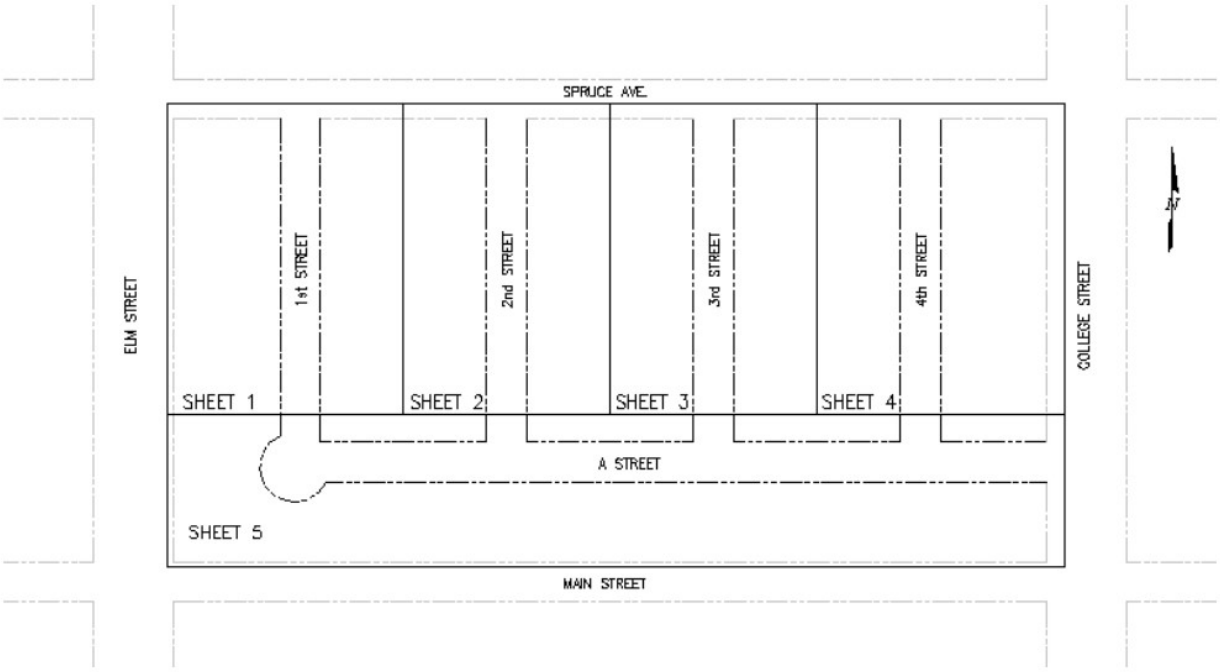
The Basis of Bearing and ties to the closest cadastral monument shall be included.

The Surveyor shall tie into a minimum of two City of Castle Pines or adjacent jurisdiction geographic information system points with the bearing and distance.

2.6.11 Overall Key Map

The Overall Key Map shall be located on the upper right-hand side. Minimum scale is 1 inch = 500 feet. Map must show the location and name of all roadways within and adjacent to the proposed construction site and all future roadways. Scale should be indicated. Key Map should be oriented consistent with the detail in the sheet (that is, same north) (refer to Figure 2-3).

Figure 2-3. Overall Key Map



2.7 Requirements for Construction Plans

All Construction Plan sheets shall include the following information:

1) Acceptance Block
2) Title Block
3) Scale
4) North Arrow
5) Stationing
6) Date of Plan
7) Seal and Signature
8) Utilities
9) Key Map

Additional specific requirements are discussed in other parts of this Submittal Procedures and Requirements chapter.

2.7.1 Scale

Scales listed are minimum. Larger scales may be required where necessary to clearly show details. This can be discussed during the pre-submittal meeting.

1) Drainage Plans, Site Plans, and the like: from 1 inch = 50 feet to 1 inch = 100 feet.
2) Plan and Profile Sheets: Horizontal 1 inch = 50 feet; Vertical 1 inch = 5 feet.
3) Details: Scales are set as needed to adequately show detailed information.

2.7.2 North Arrow

The north arrow shall point to the top or to the right margin of the sheet only; all other detail and drawings on the sheet shall be oriented consistently with the north arrow.

2.7.3 Stationing

Stationing shall be from left to right.

2.7.4 Date of Plan

The original submittal date of the plans and any subsequent revisions must be shown in the Title Block.

2.7.5 Seal And Signature

The seal and signature of the PE licensed in the State of Colorado, under whose supervision the plans were prepared, shall be located next to the Acceptance Block on each sheet, except for the City of Castle Pines Standard Detail sheets. This requirement is only on the final plans ready for acceptance.

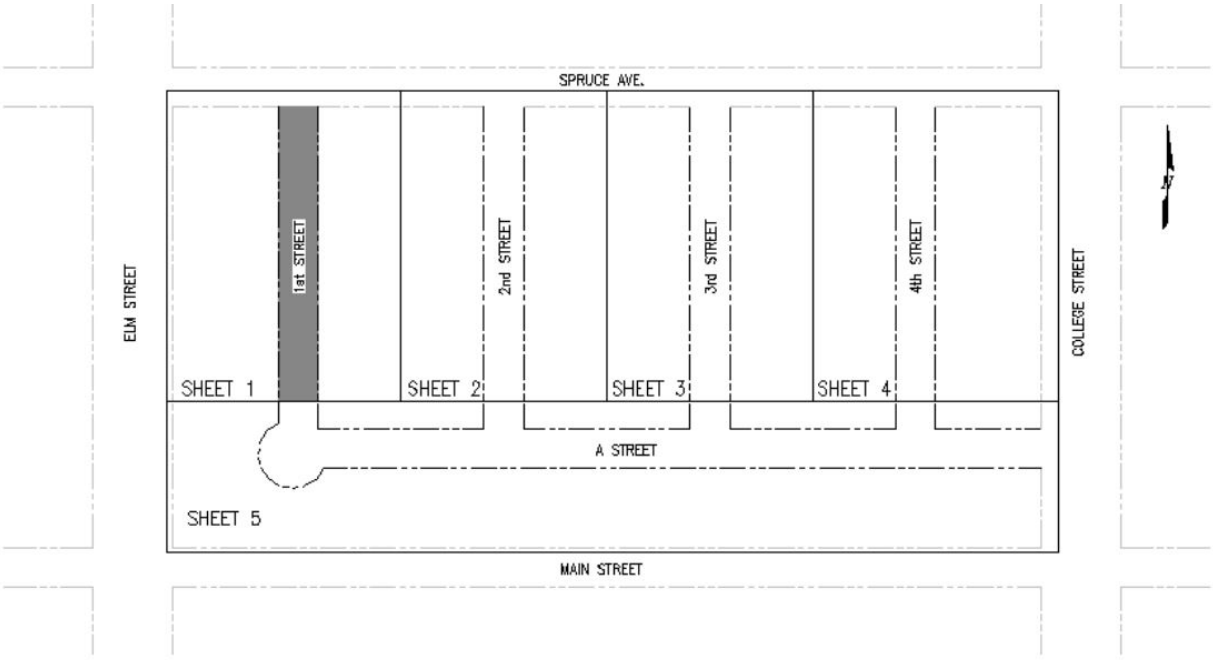
2.7.6 Utilities

The type, size, location, and number of utilities shall be shown, including utility easements. Field-verified elevations (USC&GS NAVD-88 DATUM and date) and locations are required on the Construction Plans for all utilities that will potentially affect the design or construction. It will be the responsibility of the Applicant's Engineer and Contractor to verify the existence and location of all utilities along the work route prior to commencing any new construction. Field-located utilities not shown on accepted Construction Plans shall be added to the "As-Built Drawings" and submitted as a condition for the Preliminary Acceptance of the improvements.

2.7.7 Key Map

The Key Map shall be located in the upper right-hand side of every sheet. Minimum scale is 1 inch = 500 feet. The Key Map must show the location and name of all roadways within and adjacent to the proposed construction and all future roadways. Scale should be indicated. Key Map should be oriented consistent with detail in the sheet (that is, same north). The roadway or area that the design the specific sheet pertains to will be shaded, as shown on the example Key Map on Figure 2-4.

Figure 2-4. Key Map



2.8 Requirements for Roadway Plans

In addition to the requirements set forth in Chapter 7 of these Roadway Standards, the following information shall be shown on all Construction Plans submitted for review and acceptance.

2.8.1 Plan View

The plan view shall include, but not be limited to, the following:

1) Existing and proposed property or right-of-way lines, easements, and tracts. Type and dimension of easement or tract shall be clearly labeled. Existing and proposed widths of rights-of-way shall be dimensioned.
2) Stations shall be based on the centerline only; other profiles may be included but shall be referenced to centerline stationing. Stationing is to be equated to and from flowline stationing at departures from normal roadway cross-sections. Centerline stationing is to be equated to flowline stationing at Cul-de-Sacs, Knuckles, Bubbles, and curb returns.
3) All streets and roadways must show City-accepted roadway names as shown on the plat.
4) Existing sub-surface and surface utilities and structures, including, but not limited to, waterlines, valves, fire hydrants, manholes, dry utility ditches, sanitary sewer trench and components, curb and gutter, sidewalk, storm drainage facilities, pavement limits, gas and power lines, fence lines, bridges, monuments, and utility boxes.
5) Station and critical elevation (flowline, invert, and top of pipe where applicable) of all existing and proposed utility or drainage appurtenances in rights-of-way or in easements. Location of utilities shall be dimensioned horizontally and vertically from roadway centerline profile grade.
6) Flow direction arrows for surface drainage, particularly at intersections, and all high and low points.
7) Match lines referenced to appropriate sheets.

8) Station and elevation of all horizontal curves, points of curves (PCs), points of tangents (PTs), points of curb returns (PCRs), points of compound curvatures (PCCs); high or low point of all vertical curves, existing and proposed; centerline bearings and distances and curve information on each sheet.

9) Curb return radii, existing and proposed. Stations and elevations of all curb returns; midpoint elevations, flowline-flowline intersection elevations, and percent of grade from the PCR to flowline-flowline intersections of all cross-pans.

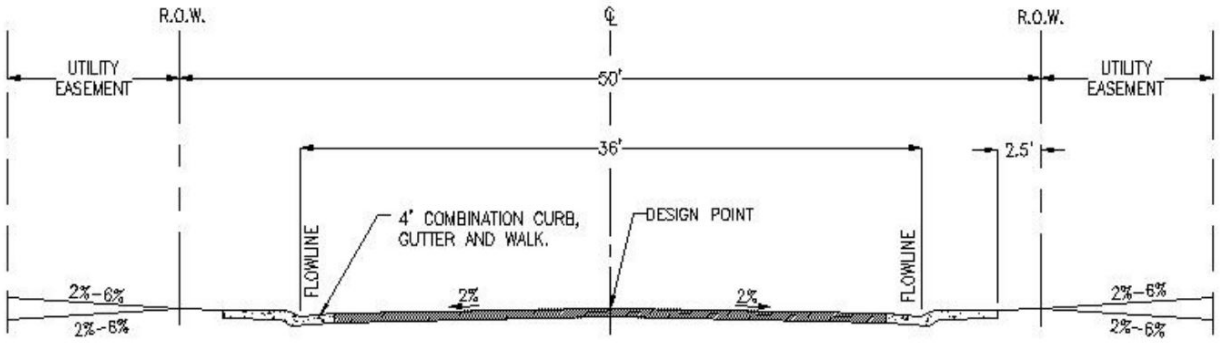
10) All curb ramp locations.

11) Centerline stations of all existing and proposed intersecting roadways and driveways except for single-family residential driveways with mountable curbs.

12) Survey tie lines to section corners or quarter corners consistent with that shown on the Final Plat. City or adjacent jurisdiction Global Positioning System (GPS)+ Control Monuments shall be shown.

13) Typical roadway cross section(s) shall be shown for all roadways, existing or proposed, within and adjacent to the proposed development. These cross-sections shall appear on the detail sheet, or if no detail sheet has been used, on the first sheet of the submittal showing the roadway design. Show cross-slope at warped intersections where cross-slope varies from the standard 2% crown. Cross-sections shall indicate type of roadway(s); design point at centerline; roadway width; right-of-way width; type of curb, gutter, and walk; and pavement cross-slope. Refer to Chapter 10 of these Roadway Standards for the methodology of submitting preliminary and final pavement design. The Final Pavement Design Report must be based on testing of finished grade after utility installation (refer to Figure 2-5).

Figure 2-5. Example: Road Name(s)



14) Any roadway intersecting an Arterial, or any Collector intersecti on requiring signalized traffic control, shall include construction and lane details for the new construction and existing facilities a minimum of 150 feet beyond the limits of construction.

15) Basis of plan view elevations and profile elevations shall reference the same (for example, flowline to flowline, centerline of roadway to centerline of roadway).

2.8.2 Profile

The profile shall include, but not be limited to, the following:

1) All design profiles shall be along the centerline and continued through the centerline of all intersecting streets. Additional profiles, such as flowline, may be shown. On streets where minimal grade is proposed, an additional flowline profile shall be provided, showing that the flowline grade around the outside of all curves meets the minimum longitudinal grade (refer to Chapter 7). The basis for record-drawing information shall be the same as the design (centerline, flowline) when possible.

2) Existing ground (dashed) along profile stationing and design grade (heavy solid). Both grades are to be clearly labeled.

3) Stationing shall be continuous for the entire portion of the roadway shown in the plan view, with the centerline station of all existing non-single-family driveways and all intersecting roadways clearly labeled.

4) All existing curbs, gutters, sidewalks, utilities, and pavement adjacent to the proposed design shall be shown. Existing elevations shall be field verified at intervals not to exceed 25 feet. Previously accepted designs are not an acceptable means of establishing existing grades. Refer to "Connection with Existing Roadways" in Chapter 7 of these Roadway Standards for additional information.

5) Station and elevation of all PCs, PTs, PCRs, PCCs, existing and proposed.

6) Station and elevation of all vertical grade breaks, existing and proposed, and slope between grade breaks. Refer to "Grade Breaks and Vertical Curves" in Chapter 7 of these Roadway Standards for additional information.

7) Vertical curves, when necessary, with point of intersection, vertical point of curvature, and point of tangency, and high or low point (if applicable) with stations and elevations. All vertical curves shall be labeled with length of curve (L), algebraic difference in slopes, in percent (A), and K-value where K = L/ A. Refer to "Grade Breaks and Vertical Curves" in Chapter 7 of these Roadway Standards for additional information.

8) Flowline profiles shall be shown for curb returns. The profile shall be extended past the curb return until the flowline profile meets the standard cross section of the street. Refer to "Curb Returns" under Chapter 7 of these Roadway Standards for additional information.

9) Flowline profiles shall be shown for all Cul-de-Sac Bubbles, Eyebrows, Knuckles, and the like. Refer to Chapter 7 of these Roadway Standards for design information.

2.9 Requirements for Drainage and Stormwater Management Facility Plans

The following sections outline requirements for Stormwater Management Facility design and plan presentation.

2.9.1 Storm Sewer and Culverts – Plan View

The plan view shall include, but not be limited to, the following:

1) Existing and proposed property or right-of-way lines, easements, and tracts

   a) The type and dimension of easement or tract shall be clearly labeled. Existing and proposed widths of rights-of-way shall be dimensioned.

2) Horizontal locations of existing and proposed pipes, inlets, manholes, junction boxes, and outlet structures with outfall protection

   b) Appropriate horizontal control shall also be shown.

3) All existing and proposed roadways, property lines, right-of-way lines, easements, and tracts

4) Utilities adjacent to or crossing the storm sewer or culvert alignment

5) Grading details at 1-foot contour intervals for all pipe and culvert inlets and outlets at a scale of 1 inch = 20 feet

6) Maintenance access improvements

7) Match lines referenced to appropriate sheets

2.9.2 Storm Sewer and Culverts – Profile View

The profile shall include, but not be limited to, the following:

1) Profile of all existing and proposed pipe mains, laterals or culverts with all inverts, rim elevations, sizes, lengths, slopes, design flow rates, and outfall protection with cutoff walls
    a) Minor and major storm hydraulic grade lines
    b) Utilities adjacent to or crossing the storm sewer or culvert alignment
    c) Vertical clearance between the top or bottom of pipe and other utility crossings, pavement section, and the like

2.9.3 Open Channels and Channel Stabilization – Plan View

The plan view shall include, but not be limited to, the following:

1) Existing and proposed property or right-of-way lines, easements, and tracts, with the type and dimension of easement or tract clearly labeled, and existing and proposed widths of rights-of-way dimensioned
2) Horizontal locations with stations of all channels, including locations of grade control structures and stabilization measures, such as check structures, drop structures, toe protection, bank stabilization, low-flow or trickle channels, with appropriate horizontal control
3) All existing and proposed roadways, property lines, right-of-way lines, easements, and tracts
4) Water Surface Limits of the Major Storm
5) Maintenance access improvements
6) Tributary channels and pipe outlets
7) Utilities adjacent to or crossing the channel alignment
8) Match lines referenced to appropriate sheets

2.9.4 Open Channels and Channel Stabilization – Profile View

The profile shall include, but not be limited to, the following:

1) Profile along channel alignments with all invert elevations and design flow rates
2) Water surface profiles for the minor storm and major storm
3) Utilities adjacent to or crossing the channel alignment
4) Typical Sections
    a) As required by channel geometry as specified by the MHFD and in the accepted drainage report

2.9.5 Detention/Storage Facilities – Plan view

The plan view shall include, but not be limited to, the following:

1) Existing and proposed property or right-of-way lines, easements, and tracts. Type and dimension of easement or tract shall be clearly labeled. Existing and proposed widths of rights-of-way shall be dimensioned.

a) Horizontal location of the pond, including locations of low-flow or trickle channels, outlet structure, emergency overflow spillways, pipe or channel inlets, with appropriate horizontal control

2) All existing and proposed roadways, property lines, right-of-way lines, existing and proposed easements and tracts adjacent to the facility

3) Grading details at 1-foot contour interval for all pipe and culvert inlets and outlets at a scale of 1 inch = 20 feet

4) Water surface limits for the minor storm, major storm, and emergency overflow conditions

5) Maintenance access and improvements

6) Utilities adjacent to or crossing the detention area

2.9.6 Detention/Storage Facilities – Profile view

The profile shall include, but not be limited to, the following:

1) Profile along low-flow or trickle channels from all inlets and structures through the outlet structure and pipe or channel with invert and outlet elevations to an existing drainageway showing the opposite stream bank

2) Invert and outlet structure elevations for pipes and channels going into the pond

3) Water surface limits for the headwater depths, minor storm, major storm, and emergency overflow conditions

4) Utilities adjacent to or crossing the detention area

5) Inlet and outlet protection

2.9.7 Water Quality Facilities not Associated with Deten tion/Storage Facilities – Plan

The plan view shall include, but not be limited to, the following:

1) Horizontal locations of the improvements

2) Existing and proposed roadways, property lines, right-of-way lines, existing and proposed easements, and tracts adjacent to the facility

3) Water surface limits for the water quality capture volume, minor storm, major storm, and emergency overflow conditions

2.9.8 Water Quality Facilities Not Associated with Detention/Storage Facilities – Profile

The profile shall include, but not be limited to, the following:

1) Profile of improvements, as necessary, to clearly define the required improvements

2) Maintenance access and improvements

3) Utilities adjacent to or crossing the detention area

2.10 Requirements for Grading, Erosion, and Sediment Control (GESC) Plans

Requirements for preparation of a GESC Plan are outlined in the City of Castle Pines GESC Manual.

2.11 Requirements for Signage and Striping Plan Sheets

All subdivisions, road improvement projects, and commercial developments must submit Signage and Striping Plan sheets within the overall Construction Plans. In addition to the requirements set forth in Chapter 9 of these Roadway Standards, the following information shall be shown on all Signage and Striping Plans submitted for review and acceptance.

2.11.1 General Provisions

All traffic control devices shall conform to the most current versions of these Roadway Standards, the MUTCD, and the Colorado Supplemental to the MUTCD. Additional specifications and illustrations are located in the Colorado Department of Transportation M&S Standard Plans and the Colorado Department of Transportation Standards for Road and Bridge Construction. The following additional provisions apply to the Signage and Striping Plans:

1) Utility Locations
    a) Sign contractors shall be responsible for locating all underground utilities.
2) End of Roadways
    a) Type III barricades shall be set at ends of roadways, separating finished and unfinished areas. A ROAD CLOSED sign shall be mounted on the barricade.

2.11.2 Signage Plan

The Signage Plan design and plan sheets shall include the following requirements at a minimum:

1) Show the general location of each existing and proposed sign (horizontal offset and station).
2) Specify the sign legend and sign code (according to the MUTCD or the CDOT Traffic and Safety website).
3) Specify the sign size.
4) Specify design speed(s) used as basis for street design (or as constructed).
5) Right-of-way and easement lines.
6) Existing and proposed trail or pedestrian crossings.

A Right-of-Way Permit must be obtained for sign installation.

2.11.3 Striping Plan

The striping design and information may be shown on the same plan sheets as the Signage Plan. Striping Plan design and plan sheets shall include the following requirements at a minimum:

1) Type, color, width, and size of all pavement markings
2) Lane and shoulder width dimensions
3) All existing striping, including striping on roads adjacent to the project area
4) Turn arrow and ONLY symbols in turning lanes
5) Begin and end stations of each type of pavement marking
6) Bike lane markings located in accordance with requirements set forth in Chapter 9 of these Roadway Standards

2.12 Requirements for Traffic Signal Plan Sheets

If a Traffic Signal is warranted and accepted by the City at an intersection, the Developer or Owner is required to submit Traffic Signal Plans sheets in accordance with the following criteria:

2.12.1 Submittal

Traffic Signal Plans sheets for proposed signalized intersections shall be produced at a scale of 1 inch = 20 feet. If needed, Traffic Signal Interconnect Plans shall be included at a scale of 1 inch = 50 feet.

For the preliminary submittal (and if required by the City for the final submittal), WB-62 turning templates, cone of vision, and stop line distance results shall be submitted as part of the plans.

The following information shall be included:

1) Traffic Signal Plan
2) Traffic Signal Interconnect Plans (if needed, as determined by City)
3) Fiber Termination Diagram (if needed, as determined by City)

2.12.2 Review Process

1) Plans are submitted by the Applicant for review and comment and returned to Applicant.
2) The Applicant submits the revised plans, the redlined comment set, and response letter for review. Plans may require several reviews prior to acceptance.

2.12.3 General Provisions

All traffic signal devices shall conform to the latest versions of Chapter 9 of these Roadway Standards, the MUTCD, and the Colorado Supplement to the MUTCD. Additional specifications and illustrations are located in the CDOT M&S Standards and the CDOT Standards for Road and Bridge Construction.

2.12.4 Pole and Mast Arm loading

The Applicant's Engineer shall provide certification that the proposed pole and mast arm loadings do not exceed the allowable loadings provided in the Traffic Signal Specifications.

2.12.5 Traffic Signal Plan

The Traffic Signal Plan shall complete the following:

1) Provide a signal-phasing diagram.
2) Show the existing lane widths (and proposed, if applicable).
3) Show crosswalk and stop bar locations.
4) Provide a legend.
5) Show details concerning the type of signal heads proposed (such as, three-section, five-section, regular or countdown pedestrian heads, pedestrian signing).
6) Show locations of pedestrian push buttons and accessible pedestrian signal equipment as applicable.
7) Include locations of vehicle detection and emergency pre-emption equipment.

8) Show legend, sign code, and size for sign panels to be mounted on mast arms and signal poles.

9) Show all topographic features close to the intersection and within the public rights-of-way that are affected by the signal installation. This includes, but is not limited to, the following:

   a) Right-of-way lines and easements

   b) Existing topographic features

   c) Existing utility locations and conflicts

   d) The location for each traffic signal pole with a northing/easting coordinate

   e) The proposed controller location

   f) The proposed power source locations and power company contact

   g) The mast arm layout showing traffic signal heads, signs, and their locations on the arm

   h) The proposed signal phasing

   i) Pedestrian heads

   j) Street name signs and proposed layout

   k) Potential street widening

These requirements must meet or exceed City standards. A Signal Warrant Study is required for any signal proposed.

2.12.6 Traffic Signal Details and Notes

See Chapter 9 for additional requirements, including standard signal details and notes.

2.13 Requirements for Landscaping Plans Within City Right-of-Way or Other City Properties or Easements

Landscape Plans are required for any landscaping proposed within the public right-of-way or that would affect the sight distance of a public or private street. Landscape Plans must show all landscaping close to and within the right-of-way. This includes, but is not limited to, the location of all plants, bushes, trees, irrigation lines, proposed street cuts, direction of drainage flows (both on the street and on the proposed landscaped area), street names, vicinity and Key Maps, general notes, and signature block. Landscaping must not screen regulatory or warning signs from approaching vehicles. Trees or large shrubs shall not be planted over buried utilities, within the sight-distance triangle at intersections or accesses, or within 10 feet of the flowline of the public street, whichever is most restrictive.

On low speed (posted 35 miles per hour [mph] or less) Minor Collectors and Local streets, trees may be planted within 6 feet of the flowline except for within 150 feet in either direction from an intersection, in which case, the trees must be a minimum of 10 feet back from the flowline. Landscaping over 36 inches above the adjacent flowline shall not be allowed within the sight triangle; however, when landscaping is located within the sight triangle, plans shall demonstrate that there is no encroachment into the line-of-sight. In no case shall trees, shrubs, or other landscaping, including branches from trees, be allowed to encroach either horizontally or vertically into the line-of-sight of the sight-distance triangle.

2.13.1 Guidelines

1) Right-of-way Landscape Plans for streets cannot be submitted for review until the Street Construction Plans have been submitted to, and accepted by, the City.

2) A Right-of-way Permit and License Agreement is required prior to landscaping activity.

3) The City does not allow installation of brick pavers in City-owned rights-of-way.

4) Noncompliance with any of the maintenance requirements in accordance with the License Agreement will result in the removal of the landscaping by the City.

5) Landscaping within the City right-of-way installed by a single-family property owner typically does not require a Landscape Plan except when the proposed landscaping does not conform to these Roadway Standards as determined by the City Development Review Engineer (that is, a sight-distance problem or landscaping blocks a sign for example).

2.13.2 Plans

Landscape Plans must show all existing and proposed improvements adjacent to and within the public right-of-way. This includes, but is not limited to, the following:

1) Project location vicinity map

2) Location of all plants, bushes, and trees with their mature dripline

3) Irrigation lines and facilities

4) Curb openings

5) Line-of-sight

6) Utilities and easements

7) Drainage flows

8) Existing and proposed trench drains

9) Right-of-way lines and tract boundaries with property ownership

10) Street centerlines and flowlines with street names

11) Project limits

12) Trails and sidewalks

13) Monumentation and planters

14) Drainage improvements

15) Floodplains

16) Traffic control devices

17) Existing and proposed contours

18) GESC improvements

19) Construction and maintenance access points

20) Standard notes

21) Landscape notes

2.13.3 Landscape Notes

The following notes are also applicable to Landscape Plans and shall be included on the Plans:

1) All trees are to be planted a minimum of 10 feet from the face of the curb of Arterial and Major Collector roadways and a minimum of 6 feet from the face of the curb of Minor Collector and Local

streets. Trees located within 150 feet of an intersection with an Arterial road must be planted a minimum of 10 feet from the face of the curb and outside of any line-of-sight requirements. The required distance of 150 feet is measured from the right-of-way line of the Arterial roadway.

2) Trees or large shrubs shall not be located over buried utilities, within 10 feet of storm sewer systems, or within the line-of-sight at intersections, accesses, or pedestrian crossings.

3) All plantings located within the line-of-sight will have a mature height of no more than 24 inches above the adjacent gutter or flowline.

4) A Right-of-Way Permit is required prior to landscaping activity within City rights-of-way, tracts, or easements.

5) Any wall or monument, over 4 feet in height, or under a surcharged condition, or with a rail on top of the wall requires a Permit from the City prior to construction. Structural plans for any wall over 4 feet in height (measured from bottom of footer to top of wall) or tiered walls, as determined by the City, will be submitted to the City prior to the issuance of the required building permit. No walls or monuments are allowed in the City's right-of-way.

6) A Permit must be obtained from the City prior to the installation of monumentation and planters outside of the public right-of-way, including those within the right-of-way of private streets. An additional Permit may be obtained from the City for lighting outside of the public right-of-way, including lighting for monumentation and planters.

7) A Traffic Control Plan shall accompany the application for a Right-of-Way Permit.

8) Trench drains shall not have angles greater than 45 degrees.

9) Maximum spacing between trench drain cleanouts shall be 200 feet.

10) Trench drains shall not discharge into the gutter or flowline.

11) Trench drain crossings under pavement shall be installed prior to paving, or shall be installed by boring under roadway.

2.14 Requirements for Construction Plans for Multifamily Site Improvement Plans

Construction Plans are separate from the Site Improvement Plan (SIP). Construction Plans must be accepted prior to SIP approval. The following items may be required:

1) Cover Sheet

2) Overall Utility Plan

3) GESC Plan (see City of Castle Pines GESC Manual)

4) A detailed Fine Grading Plan (20 scale drawings with spot elevations)

5) Street Plan and Profiles

6) Typical Roadway Cross-sections

7) Storm Sewer and Culvert Plan and Profiles – show all other utilities, including depth and size, on the profiles

8) Drainage Plan (see City of Castle Pines Drainage Criteria)

9) Detail Sheets

10) Other items as determined necessary by the City

2.15 Requirements for Construction Plans for Non -Residential Site Plans

Construction Plans are separate from the SIP. Construction Plans must be accepted prior to SIP approval. The following items may be required:

1) Cover Sheet
2) Overall Utility Plan
3) GESC Plan (see City of Castle Pines GESC Manual)
4) A detailed Fine Grading Plan (20 scale drawings with spot elevations)
5) Curb Return Profiles (if necessary)
6) Typical Roadway Cross-sections
7) Storm Sewer and Culvert Plan and Profiles
8) Drainage Plan (see City of Castle Pines Drainage Criteria)
9) Detail Sheets
10) Other items as determined necessary by the City, to be identified during the pre-submittal meeting

2.16 Requirements for Construction Plans for Single -Family Residential Development

The Construction Plans must be accepted prior to Final Plat approval. The following items may be required:

1) Cover Sheet
2) Overall Utility Plan
3) GESC Plan (see City of Castle Pines GESC Manual)
4) Street Plan and Profiles
5) Curb Return Profiles (if necessary)
6) Typical Roadway Cross-sections
7) Drainage And Stormwater Management Facilities
8) Drainage Plan (see City of Castle Pines Drainage Criteria)
9) Detail Sheets
10) Other items as determined necessary by the City, to be identified during the pre-submittal meeting

2.17 Requirements for Overall Utility Pla ns

In addition to the requirements set forth in these Roadway Standards, the following information shall be shown on the Overall Utility Plan submitted for review. Maximum scale shall be 1 inch = 200 feet.

1) Existing and proposed property or right-of-way lines, easements, and tracts. The type and dimension of easement or tract is to be clearly labeled. Property lines and right-of-way lines are to be dimensioned.
2) The type, size, location, and number of all existing and proposed underground and aboveground utilities shall be shown.

2.18 Requirements for Utility -Only Construction Plans

In addition to the requirements set forth in Chapter 4 of these Roadway Standards, the following items are required in the Construction Plans:

1) Cover Sheet
2) Overall Utility Plan Sheet
3) GESC Plan (see City of Castle Pines GESC Manual)
4) Utility Plan Sheets (all utilities with the exception of water, sanitary, and storm)
5) Traffic Control Plan
6) Temporary Construction Access Detail Sheet, if applicable
7) Detail Sheets
8) Other items as determined necessary by the City, to be identified during the pre-submittal meeting

2.18.1 Utility Plan Sheets

1) Plan view showing type, size, location, separation from other utilities, and number of all existing and proposed underground and aboveground utilities shall be shown with appropriate horizontal control.
2) Existing and proposed roadways, property or right-of-way lines, easements, and tracts. Type and dimension of easement or tract is to be clearly labeled. Property lines and right-of-way lines are to be dimensioned.
3) If public roadways are crossed, a profile of the crossing shall be provided.

2.19 Requirements for Detail Sheets

Applicable City of Castle Pines Standard Details found in the Appendix of these Roadway Standards shall be included in the Construction Plans. The Plans shall include adequate details of special structures not covered by the City of Castle Pines Standard Details. The document accepted by the City, which includes the standard detail and special structures, shall be available on the job site at all times. Nonstandard details shall be submitted on a separate sheet (within the Construction Plans) accepted by City and require a certification by a PE licensed in the State of Colorado.

2.20 Range Points – Property Monuments – Benchmarks

1) All survey monuments delineating property boundaries, or witness thereof, shall be set in accordance with these Roadway Standards and all applicable State of Colorado laws and regulations.
2) Any aliquot corner (section corner or quarter corner, for example) as described in the Public Land Survey System shall be monumented per Colorado State Statutes. If such a corner falls within concrete or asphalt, a range box (as shown in Appendix A) shall be installed to protect and provide access to said corner. If corner falls outside of pavement, a monument marker must be placed next to the corner.
3) If so desired, the Developer may install additional range boxes in asphalt or concrete for property monuments, range points, benchmarks, and the like. The boxes must comply with the City of Castle Pines Range Box Standard Detail.

2.21 Variances and Appeals

2.21.1 General Variances

Variance(s) shall be identified in the initial submittal of Construction Plans. The Variance request(s) shall consist of the following:

1) Identification of the criteria provision to be waived or varied.
2) Identification of the alternative design or construction criteria to be adhered to.
3) A thorough justification of the variance request, including impact on capital and maintenance requirements and cost.
4) The Variance shall be stamped and signed by a PE licensed in the State of Colorado with the following note:

   "This Variance Request from the City of Castle Pines Roadway Design and Construction Standards, Section (include the section number and name) for (name of subdivision, development, or project) was prepared by me (or under my direct supervision) and is based on sound engineering practices."

   Name of Engineer
   Name of Firm

If more than one Variance is requested for public facilities, Alternate Roadway Standards may need to be processed. If more than one Variance is requested for private facilities, Private Roadway Standards may need to be processed.

2.22 Alternate Roadway Standards

Alternate Roadway Standards, based on sound engineering criteria, may be proposed for roads that will be owned and maintained by the City. These Alternate Roadway Standards must be certified as to their adequacy and safety by a PE licensed in the State of Colorado. The Alternate Roadway Standards must contain a list of all deviations from City criteria, as well as references to all sources that support the adequacy of the proposed deviations. The Alternate Roadway Standards shall be subject to acceptance by the governing Fire District and the City.

Chapter 3 - Public Improvement Cost Estimates

3.1 General

Any application for Subdivision or Site Plan acceptance will require an Improvements Agreement to secure the improvements. The following documents may be obtained from the City of Castle Pines' website.

3.2 Improvement Agreements for Subdivisions

The State of Colorado's subdivision statutes and the City's Subdivision Resolution authorize the execution of a Subdivision Improvements Agreement (SIA) between the City and Developer whereby the Developer agrees to construct any required public improvements for the Subdivision and to provide security for completion of the Subdivision Improvements.

3.2.1 Subdivision Improvements Agreement

1) If improvements are dedicated to Castle Pines by way of a plat, an SIA is required.
2) If the project contains both public and private improvements, both an SIA and a Subdivision Improvements Agreement for Private Development (SIA-Private) will be required.

3.2.2 Subdivision Improvements Agreement for Private Development

1) If improvements are private and dedicated to a homeowner's association or district, a SIA-Private is required.
2) If the project contains both public and private improvements, both a SIA and a SIA-Private will be required.

3.2.3 Public Improvements Agreement

1) If a project is not processed through a Subdivision application, and public improvements are required, a Public Improvements Agreement (PIA) may be required.

3.3 Improvement Agreements for Site Improvement Plans

If a parcel or site is developed or redeveloped through a Site Improvement Plan, a Site Improvement Plan Improvements Agreement (SIPIA) is required.

3.4 Cost Estimate Exhibits

The following cost estimate exhibits shall be prepared, signed (by the same individual who signs the agreement) and attached to the agreement.

3.4.1 Exhibit A

Exhibit A – Cost Estimate for SIA, SIA-Private, PIA, SIPIA, or other agreements shall include the following:

1) Roadway improvements, including pavement sections, sidewalk, trails, curb and gutter, curb ramps, and trench drains as identified by the City-accepted construction plans for the subdivision.
2) Structures, including bridges, culverts, retaining walls, and other such features.
3) Stormwater improvements, including inlets, pipes, culverts, channels, ditches, hydraulic structures, riprap, detention basins, forebays, micro-pools, and water quality facilities.

4) Utility improvements, including water and sanitary sewer facilities, lines, metering stations, pump stations, lift stations, reservoirs, distribution mains, and laterals that serve the development. The cost estimate does not need to include the service taps and meters for individual utility users that are located outside of the right-of-way. If these costs are secured through a Utility District, the City will not require security for these improvements. The Exhibit shall identify the utility cost and must note that the Utility District holds the security for the improvements. The City will require written verification from the Utility District.
5) Traffic signal improvements and signage and pavement marking improvements shall be included when required.
6) Parking lot improvements, including pavement sections, sidewalk, curb and gutter, and curb ramps for a site improvement plan.

3.4.2 Exhibit B

A separate Exhibit B may be required in accordance with the City's requirements, including, but not limited to, all costs associated with any required landscape plan.

3.4.3 Security Requirements

Security for the improvements included in the subdivision agreements shall be in the form of an irrevocable letter of credit or cashier's check for the total amount, including contingencies. Bonds are not an acceptable form of security.

3.4.4 Separate Exhibits

Separate exhibits are required if fair share participation of improvements is required, such as future traffic signals or road widening. The extent of participation shall be determined by the City.

3.4.5 Determination of Unit Costs for improvements

The City will provide standard unit costs for the construction of standard improvements in the right-of-way. These unit costs will be derived from the bids on capital projects. If the City does not have a unit cost for an improvement, the developer may use Colorado Department of Transportation costs or Mile High Flood District standard costs.

3.5 Phasing Plan for SIA and SIA-Private

The City requires that all residential subdivision improvements included in the construction documents be built or completed, inspected, and accepted by the City prior to any conveyance or transfer of title to any lot, lots, tract, or tracts of land within a phase, or prior to any building Permit(s) being issued. This may, and in most cases will, require a Phasing Plan for proper street acceptance. Section 3.5.2 provides submittal requirements for Phasing Plans.

3.5.1 Phasing Considerations

Careful consideration shall be given when developing a Phasing Plan. Streets that are to be granted Preliminary Acceptance shall be accessible by a street that has already been granted Preliminary Acceptance or will be granted such acceptance as part of that phase. All lots that take access from those roads, as well as all adjacent disturbed areas, shall be included in each phase. If detached sidewalks or

trails are built in a later timeframe, the detached walk or trails shall be placed into a separate and distinct phase. The following specific requirements shall be complied with when developing a Phasing Plan:

1) A maximum of 40 lots shall take access from any one access point.
2) The maximum length of roadway(s) providing single-point access shall not exceed 1,200 feet.
3) A temporary Cul-de-Sac with a minimum radius of 45 feet paved or stabilized with a Fire-District-accepted surface shall be required at the end of the roadway segment. The temporary Cul-de-Sac will require a Temporary Roadway Easement to be granted until future roadway improvements are accepted.
4) The drainage improvements associated with each phase shall be shown on the Phasing Plans, constructed, and accepted at the same time as the streets. Drainage improvements shall be included within the phases. Detention or water quality facilities serving more than one phase shall be installed at the start of the earliest phase to be constructed so that the facilities are in place when any portion of the upstream area is disturbed.
5) The Phasing Plan shall reflect the Final GESC Drawing Best Management Practices so that each phase provides adequate erosion and sediment controls.

3.5.2 Plan Requirements

If a detached, single-family residential subdivision is planned to have the streets phased, a separate Phasing Plan shall be required. The individual who signs the SIA or SIA-Private needs to also sign the Plan. Submittal requirements for Street Acceptance Plans, at a minimum, shall include the following:

1) Phase delineation lines and phase labeling that clearly define how each phase divides, including streets, lots, drainage improvements, and adjacent disturbed areas of each phase
2) Lot lines
3) Street names
4) Lot and block number on each lot
5) Drainage improvements

Chapter 4 - Utility Locations Design and Construction Standards

4.1 Plans Required

Any utility or other facility constructed in a City-owned right-of-way shall have Construction Plans submitted and approved in accordance with requirements of these Roadway Standards. No construction Permit shall be issued for construction of new utilities or extension of existing utilities without prior review and approval of the Construction Plans by the City. Permits are required with the following exceptions:

1) Minor maintenance projects may be exempt from submitting formal Construction Plans. In such cases, however, sketch plans must accompany the Permit Application. Utility companies may be exempt from requiring a Professional Engineer's (PE) (licensed in the State of Colorado) signature and stamp on the Construction Plans if the project is of a nature that would not warrant design by a registered PE.
2) To avoid delays and redesigns on large projects and in areas where future road improvements are expected, plan and profile sheets may be requested. A predesign meeting must be held with the City or authorized representative to discuss the requirements of the plan submittal. The City will assist the utility company in determining which future roadway profiles and improvements are expected to minimize future utility relocations. Requirements for submitting plan and profile sheets may be waived upon written request of the utility company. This exception does not apply to water and sewer line projects. Water and sewer plans must be approved by the applicable District.

4.1.1 Formal Plans

If formal plans are required, the City will notify the Applicant of such within 48 hours after the predesign meeting.

4.1.2 Deviations

The Applicant's completed facility shall conform with the drawings or sketches referred to previously unless a deviation has been requested and approved by the City.

4.1.3 Pipelines

When the proposed facility involves pressure pipelines, the following additional data are required:

1) Design pressure of pipe
2) Normal operating pressure
3) Maximum operating pressure
4) Nominal composition of material in pipeline

This information is for reference only.

4.2 Design Standards

4.2.1 General

All work in connection with the facility authorized by the Permit shall be done in a neat and efficient manner to the City's satisfaction. Construction details of the same shall conform to the requirements in effect at the time of Permit issuance.

4.2.2 Utilities

All utilities, including water, sanitary sewer, and storm sewer shall be stubbed out to the right-of-way at all locations that are planned for future tie-ins. Other reasonable stub-outs may be requested by the City based on sound engineering judgment and knowledge of adjacent development.

4.2.3 Gravity Utilities Precedence

Precedence shall be given to gravity utilities (for example, sanitary and storm sewer) over other utilities in design and construction.

4.2.4 Access Covers

All manhole lids, utility access covers, and range box access covers shall be depressed one-quarter an inch to half an inch below the adjacent finished street surface.

4.2.5 Sleeves

During initial construction, utility companies shall install relevant utilities within sleeves across all public streets to accommodate future repairs without street cuts. Sleeves shall be of a size and material appropriate for the specific utility and shall be designed to withstand road loading. Sleeves shall be installed at a minimum depth of 42 inches to the top of the pipe from the top of the curb, and ends shall be sealed except for necessary vents or drains.

A minimum of six additional sleeves on Arterials, and a minimum of four additional sleeves on Collectors are to be installed by the Developer at all street intersections along both sides of all Collectors and Arterials and at intersections of Local streets where there is a utility corridor. Any intersection along a Collector or Arterial that may warrant signalization shall have additional sleeves (as described previously) installed across the streets at the intersection.

Sleeve quantity, location, size, and material shall be approved by the City.

4.3 Location

During design or prior to construction of the following, potholing or similar subsurface utility investigation shall be performed to identify the location(s) of other utilities. Refer to Figures 4-1, 4-2, and 4-3.

4.3.1 Water

Waterline and service locations require acceptance from the applicable District. Where possible, water mains shall be located on the northern and eastern sides of streets. Water mains shall be placed at a minimum depth of 4.5 feet measured from top of main perpendicularly to the finished ground surface. Water service lines shall be placed at a minimum depth of 4.5 feet to the right-of-way line. Water mains shall be separated from sanitary sewer mains by a minimum of 10 feet measured horizontally. Fire hydrant locations are subject to Fire District requirements. Where no such requirements exist, fire hydrants shall be located 3 feet minimum from the back of the curb, 1 foot minimum from the back of an attached sidewalk, or 10 feet minimum from the edge of pavement if no curb is present.

4.3.2 Sanitary Sewer

Sanitary sewer and service locations require acceptance from the applicable District. Where possible, sanitary sewer mains shall be located on the southern and western sides of streets. Sanitary sewer mains

shall be placed at a minimum depth of 5 feet measured from the top of main perpendicularly to the finished ground surface. Sanitary sewer service lines shall be placed at a minimum depth of 5 feet to the right-of-way line.

4.3.3 Storm Sewer

Storm sewers shall be located as needed for adequate utility separation. Storm sewer depths are subject to minimum and maximum cover requirements associated with the storm sewer manufacturer, but at no time shall storm sewers be placed at a depth less than 2 feet from the top of pipe measured perpendicularly to the road surface.

4.3.4 Natural Gas

Where possible, gas mains shall be located either within the right-of-way or in an adjacent easement on the southern and western sides of the street.

4.3.5 Electric Power, Cable Television, and Communications

Where possible, electric power, cable television, and communications lines shall be located in the northern and eastern sides of the street, either within the right-of-way or in an adjacent easement. Location is also subject to requirements in the National Electrical Safety Code (NESC).

4.3.6 Additional Structures

Poles, signs, and any other aboveground streetscape (except regulatory signs) shall be generally located within 5 feet of the right-of-way line or 10 feet from the travel lane (flowline), whichever is more restrictive. Where existing roadways are constructed to something other than present City standards, variances will be considered on a case-by-case basis. Light poles may be placed a minimum of 2 feet behind a vertical curb line, or 2 feet behind the sidewalk for attached sidewalk conditions with prior written approval by the City. Poles placed within City rights-of-way having a posted speed limit of 40 mph, or higher, may be required to be breakaway, per the Colorado Department of Transportation Roadway Design Manual. All poles within City rights-of-way must be accepted by the City prior to the Permit Application for installation.

4.3.7 Location Deviations

Utility locations other than those stipulated in this chapter may be considered if given written approval by the City.

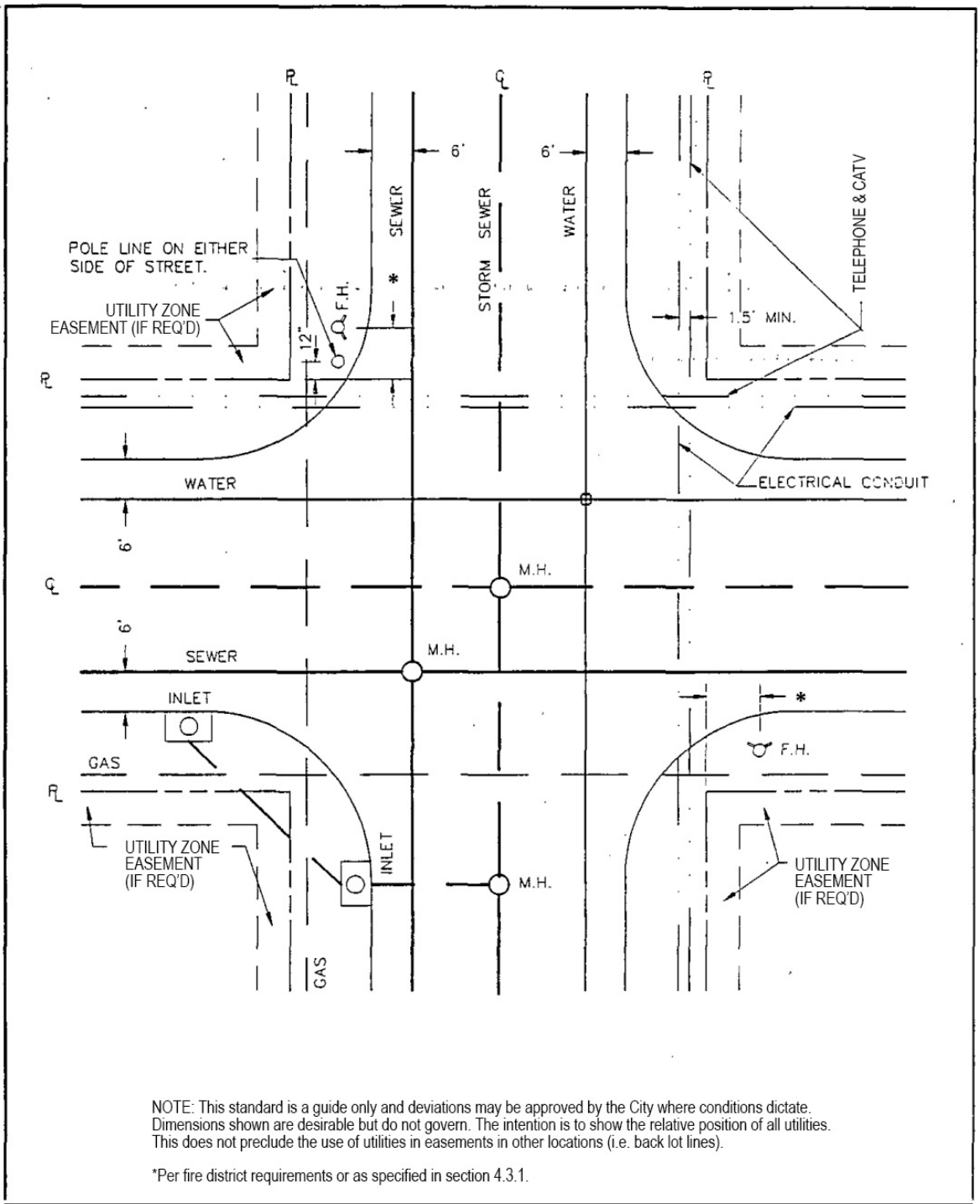
4.3.8 Boring or Directional Drilling

For pipelines or conduits to cross roads, boring or directional drilling may be required instead of trenching, as directed by the City. If sufficient rights-of-way exist, the length of the bore shall extend a minimum of 4 feet from the edge of the pavement when possible. Unused holes or abandoned casings shall be backfilled. Water boring under roadways shall not be permitted. Existing carriers and conduit installed under a roadway shall be physically located prior to boring.

4.3.9 Subsurface Utility Locating

Location markers, tracer wires, as-built drawings, and other methods of establishing locations of underground utilities after burial shall be provided as required by the utility owner and are subject to City approval.

Figure 4-1. Utility Line Location: Typical Plan



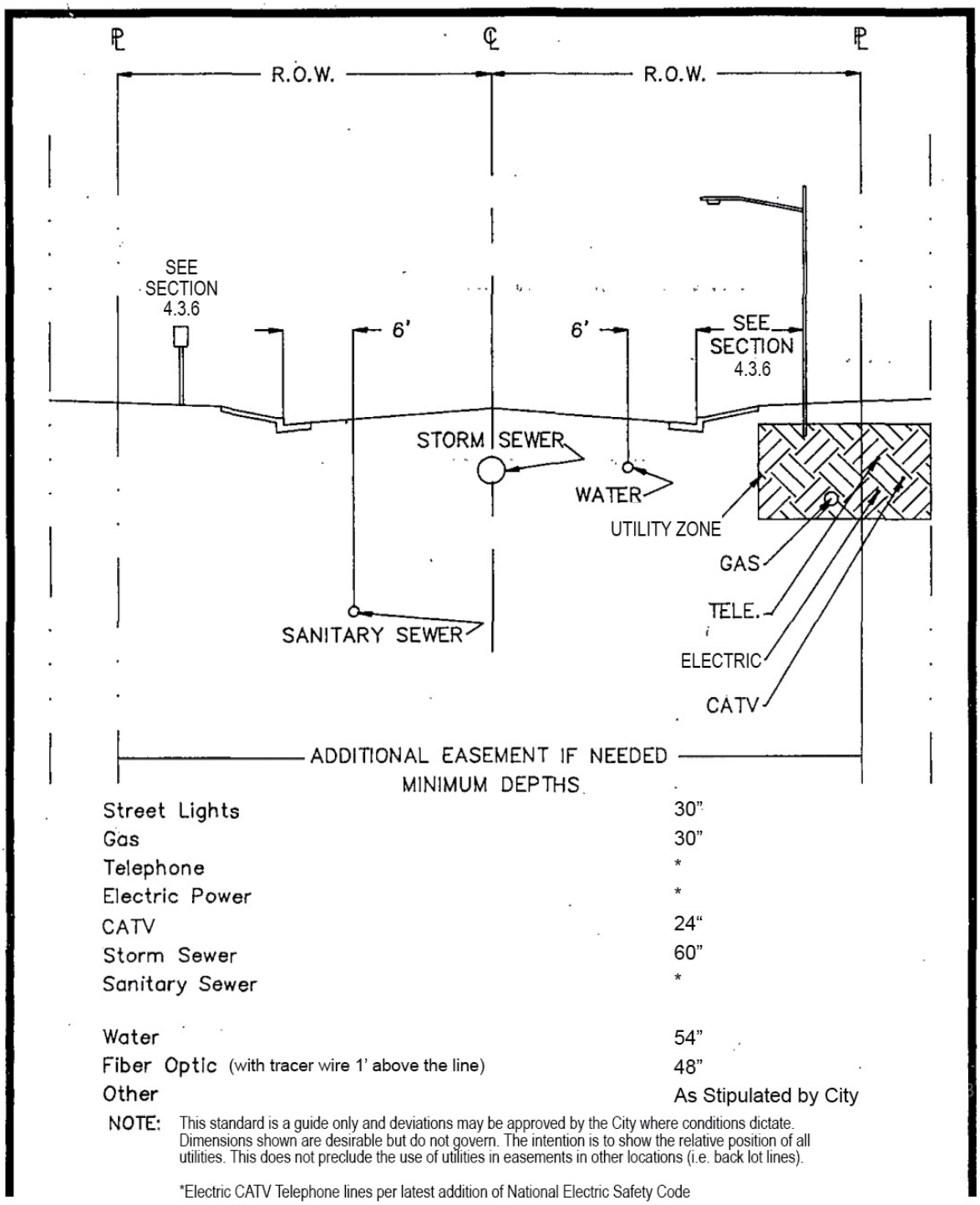
NOTE: This standard is a guide only and deviations may be approved by the City where conditions dictate. Dimensions shown are desirable but do not govern. The intention is to show the relative position of all utilities. This does not preclude the use of utilities in easements in other locations (i.e. back lot lines).

*Per fire district requirements or as specified in section 4.3.1.

UTILITY LINE LOCATION
TYPICAL PLAN

Figure 4.1

Figure 4-2. Utility Line Location: Typical Section



MINIMUM DEPTHS

Street Lights	30"
Gas	30"
Telephone	*
Electric Power	*
CATV	24"
Storm Sewer	60"
Sanitary Sewer	*
Water	54"
Fiber Optic (with tracer wire 1' above the line)	48"
Other	As Stipulated by City

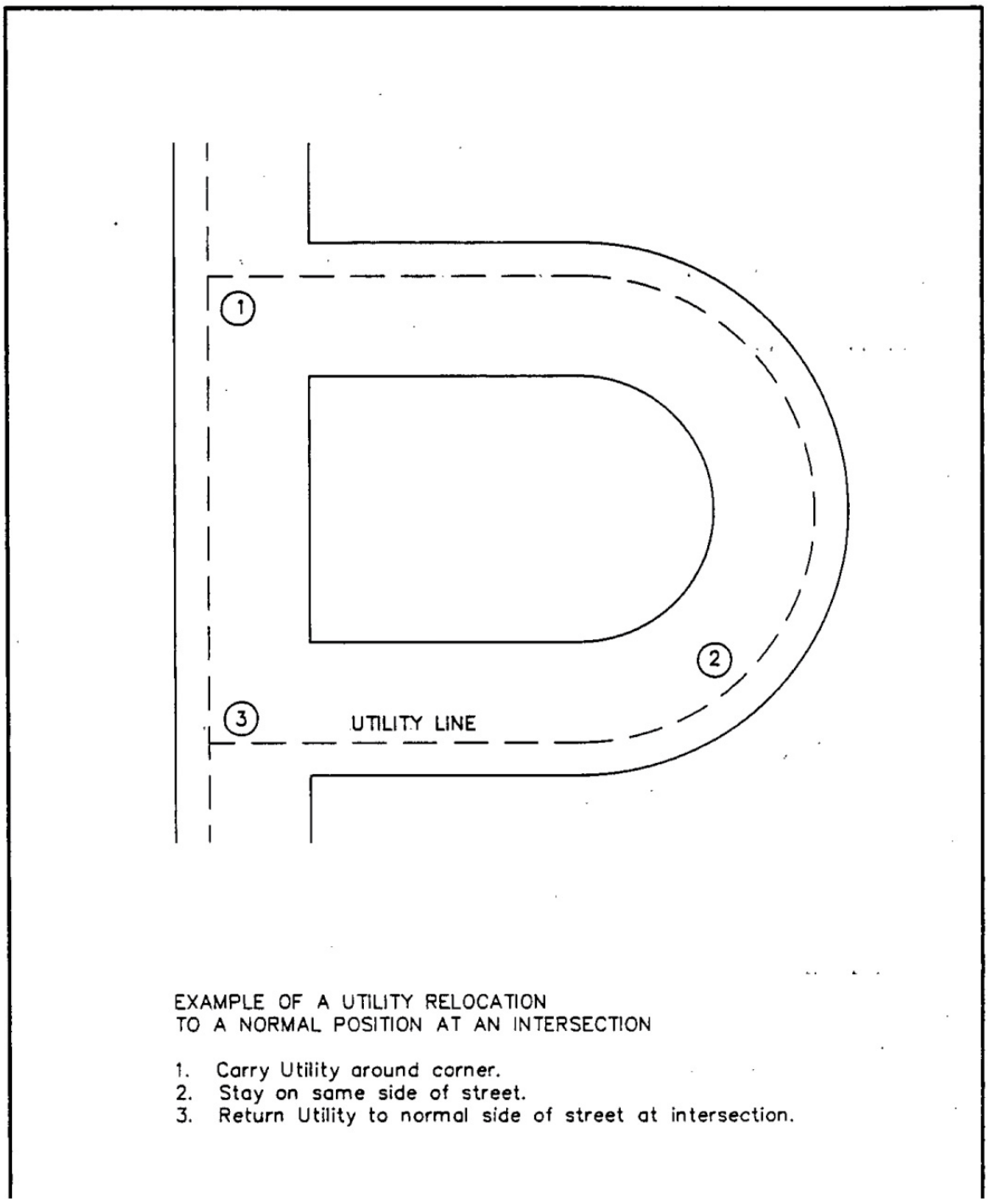
NOTE: This standard is a guide only and deviations may be approved by the City where conditions dictate. Dimensions shown are desirable but do not govern. The intention is to show the relative position of all utilities. This does not preclude the use of utilities in easements in other locations (i.e. back lot lines).

*Electric CATV Telephone lines per latest addition of National Electric Safety Code

UTILITY LINE LOCATION
TYPICAL SECTION

Figure 4.2

Figure 4-3. Utility Line Relocation Example



UTILITY LINE LOCATION
UTILITY RELOCATION EXAMPLE

Figure 4.3

Chapter 5 - Access Requirements and Criteria

5.1 General Application Process

Access requests to City streets and roadways are processed through one of the following methods:

5.1.1 Access for Planned Unit Development

Unit Development Process (and Site Improvement Plan, if applicable) may set general locations for access points.

5.1.2 Access for New Subdivisions

For new subdivisions, access is granted through the platting process.

5.1.3 Access for Commercial, Industrial Properties

For commercial, industrial, multifamily and single-family developments, access is granted through the development process. For all new developments, the final driveway location shall be determined at the time of building Permit and shall meet these requirements.

5.1.4 Special Circumstances

Single-family residential driveway Permits shall be issued through the City offices for special circumstances.

5.1.5 Other

In some circumstances, the City may require a Right-of-Way Permit for subdivision, commercial, industrial, or multifamily access. City staff is available to provide assistance on the extent of technical justification required for any access request. It is recommended that this assistance be sought prior to submitting any application.

5.2 Criteria for Access onto Streets within the City

5.2.1 Freeways

New freeway access in the City shall meet the requirements of Colorado Department of Transportation (CDOT) or the appropriate governing authority. Access requests are made through CDOT and must follow CDOT's established process.

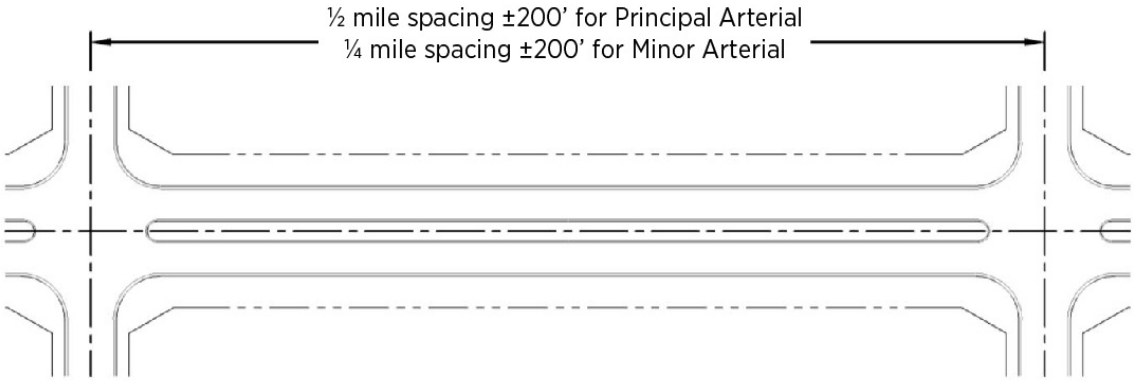
5.2.2 State Highways

Access to State Highways is governed by the State Highway Access Code.

5.2.3 Principal and Minor Arterials

Figure 5-1 shows different types of Principal and Minor Arterial access.

Figure 5-1. Principal and Minor Arterials



Principal or Minor Arterial
Major or Minor Collector
Entry Street
School Access Street
Commercial and Industrial

Principal or Minor Arterial
Major or Minor Collector
Entry Street
School Access Street
Commercial and Industrial

5.2.3.1 Private Access

Generally, no private, full-movement access shall be allowed onto Principal and Minor Arterials unless a signal progression plan has been reviewed and accepted by the City. This plan must prove that this private access will not reduce progression bandwidth or otherwise degrade traffic operations for the Principal or Minor Arterials. Private direct access to Principal and Minor Arterials may be permitted only when the property in question has no other reasonable access to the general street system, or when denial of direct access to the Principal and Minor Arterials and alternative direct access to another roadway would cause unacceptable traffic operation and safety problems to the overall traffic flow of the general street system. When private access must be provided, the following shall be considered:

1) Such access shall continue only until such time that some other reasonable access to a lower classification street is available and permitted. This street must be included in the City's Master Transportation Plan. The Permit should specify the future reasonable access location(s), circumstances, and modifications required to change the access location. The timing of the modifications and a funding commitment by the Applicant to enact the changes must be specified in the Permit.

2) No more than one access shall be provided to an individual parcel or to contiguous parcels under the same ownership unless it can be shown that (1) allowing only one access conflicts with safety regulations (such as fire access), or (2) additional access would significantly benefit the safety and operation of the highway or street and is necessary for the safe and efficient use of the property.

3) An access shall be limited to right-in/right-out movements only unless (1) it has the potential for signalization, and (2) left turns would not create unreasonable congestion or safety problems and lower the level of service. The City may require provision of deceleration and acceleration lanes for the right-in/right-out only movements. The Applicant should discuss this potential with the City prior to submitting the Permit.

5.2.3.2 Public Access

Where left turns are to be permitted, public direct access to Principal and Minor Arterials must meet the City's signal spacing criteria. Those that do not meet these requirements shall be limited to right-in/right-out movements only, unless they meet the requirements described previously. No Local streets shall be permitted to intersect Principal and Minor Arterials.

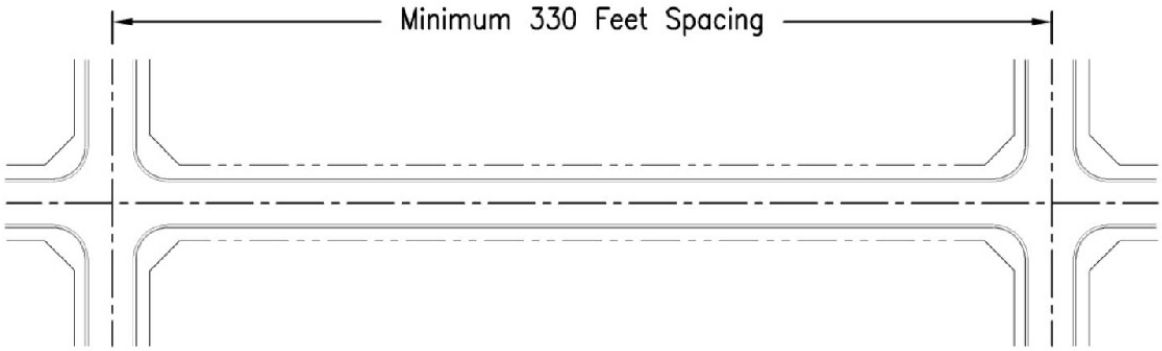
Full-movement access (from Principal and Minor Arterials, Major and Minor Collectors, Entry Streets, School Access Streets, Commercial Streets, and Industrial Streets) to Principal and Minor Arterials shall be limited to half-mile intervals (for Principal Arterials), and quarter-mile intervals (for Minor Arterials), plus or minus 200 feet, to achieve good speed, capacity, and optimal signal progression. To provide flexibility for both existing and future conditions, an accepted engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization. The specifics of this analysis are detailed in the "Traffic Impact Study Criteria" (refer to Chapter 6).

If the access location is not accepted through the land development process, a Right-of-Way Permit must be obtained from the City for any private access requested to an Arterial.

5.2.4 Major and Minor Collectors

Figure 5-2 shows different Major and Minor Collector access.

Figure 5-2. Major and Minor Collectors



Private access to Major and Minor Collectors shall be governed by the following curb opening and driveway criteria. Single-family residence access to Major and Minor Collectors is not permitted unless access to a lower classification street is not available.

The minimum centerline-to-centerline spacing between Major and Minor Collectors and Local Streets is 330 feet.

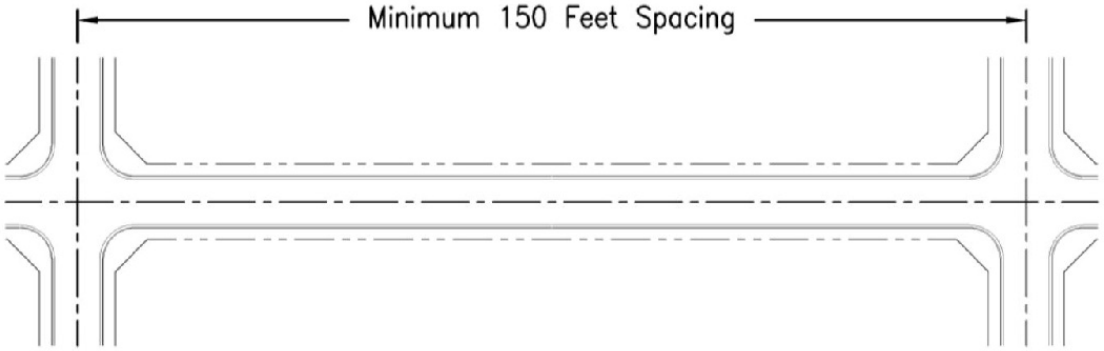
The closest Local Street intersection to a Principal or Minor Arterial along a Major or Minor Collector shall be 330 feet as measured from the Principal or Minor Arterial right-of-way line to the centerline of the Local Street.

If the access location is not accepted through the general application process, a Permit must be obtained from the City for any private access requested to a Minor Collector.

5.2.5 School Access Street

Figure 5-3 shows different types of School Access Streets.

Figure 5-3. School Access Streets



Entry Street
School Access Street
Commercial and Industrial
Local Street

Entry Street
School Access Street
Commercial and Industrial
Local Street

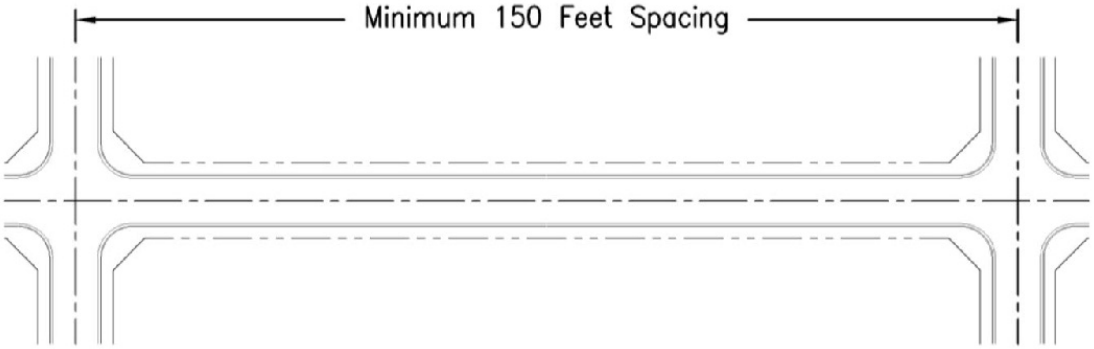
Private access to a School Access Street shall be governed by the following curb opening and driveway criteria as well as Douglas County criteria:

1) Streets should not intersect a School Access Street closer than 150 feet from each other (centerline to centerline). On a School Access Street, the closest intersection to a Major or Minor Collector Street shall be at least 200 feet (centerline to centerline).
2) No signalization shall be allowed on a School Access Street.
3) A Permit must be obtained from the City for any access other than single-family residential access to a School Access Street.

5.2.6 Commercial and Industrial

Figure 5-4 shows different types of Commercial and Industrial access.

Figure 5-4. Commercial and Industrial Access



Entry Street
School Access Street
Commercial and Industrial
Local Street

Entry Street
School Access Street
Commercial and Industrial
Local Street

Private access to Commercial and Industrial Streets shall be governed by the following curb opening and driveway criteria:

1) Streets shall intersect Commercial and Industrial Streets not closer than 150 feet from each other (centerline to centerline). The closest Local Street intersection along a Commercial and Industrial Street to a Major or Minor Collector shall be 200 feet (centerline to centerline). Refer to Figure 5-5.
2) Signalization shall not be allowed on Commercial and Industrial Streets.
3) A Permit may be required from the City for any private access requested to Commercial and Industrial Streets.
4) In an effort to limit the number of "Points of Conflict" on Commercial and Industrial Streets, access to these streets should be limited to shared driveways located at common lot lines.

5.2.7 Entry Streets

Private access to Entry Streets is not allowed.

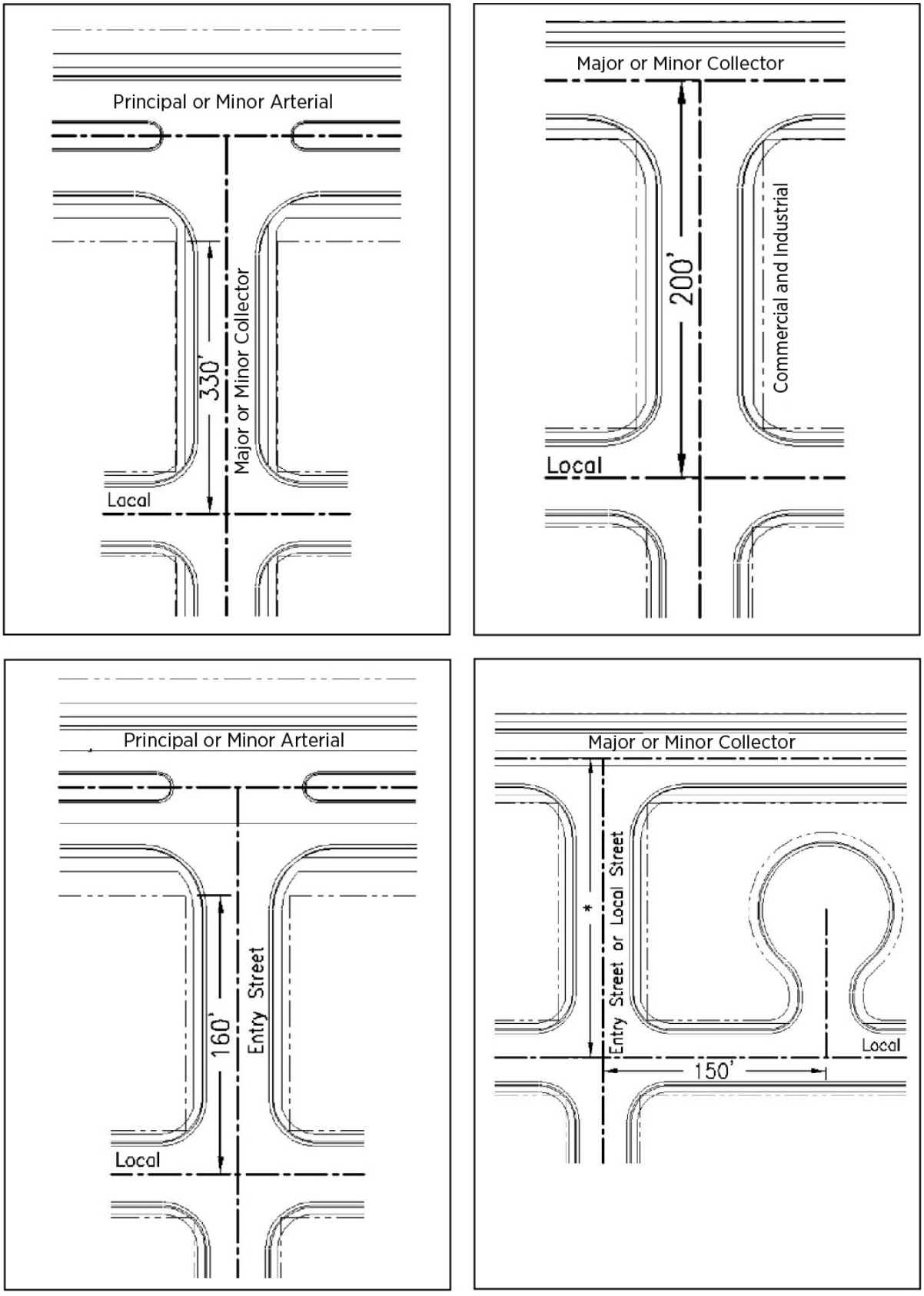
1) The closest Local Street intersection along an Entry Street to a Principal or Minor Arterial shall be 160 feet as measured from the Principal or Minor Arterial right-of-way line to the centerline of (the Local Street. The closest Local Street intersection along an Entry Street to a Major or Minor Collector shall be 160 feet (centerline to centerline). Refer to Figure 5-5.
2) Signalization shall not be allowed on an Entry Street.

5.2.8 Local Streets

Private access to local streets shall be governed by the following curb opening and driveway criteria:

1) Intersections between shall be spaced no closer than 150 feet (centerline to centerline). The closest Local Street intersection along a Local Street to a Major or Minor Collector shall be 200 feet (centerline to centerline).
2) Signalization shall not be allowed on a Local Street.
3) Single-family residential accesses to Local Streets are issued by the Building Department in accordance with this chapter.

Figure 5-5. Intersection Separation for Entry Street and Local Streets



5.3 Basic Principles for Curb Openings and Driveways

By controlling the location and width of curb openings or driveways along the street, it is possible to avoid or eliminate long, open stretches where motorists can indiscriminately drive onto the street. In case of conflict between requirements in the various sections of this chapter, the more restrictive will apply. The opening or driveway width should be adequate to properly handle the anticipated traffic volumes and types of vehicles expected to use the driveway. Its location should be completely within the property boundary lines.

Driveway openings shall be located at the point of optimum sight distance along the street. For openings and driveways to commercial establishments, there shall be sufficient space cleared of any obstructions so that drivers entering or exiting the property are given sufficient sight distance to enable them to make proper and safe turning movements. The profile of a driveway approach and the grading of the adjacent area shall be designed so that when a vehicle is located on the driveway outside the travel lanes of the street, the driver can see a sufficient distance in both directions to enable the driver to safely enter the street without impeding traffic flow.

Any adjustments that must be made to utility poles, streetlight standards, fire hydrants, inlets, traffic signs and signals, utility boxes, or other public improvements or installations that are necessary as the result of the curb openings or driveways shall be accomplished without any cost to the City. Any curb opening or driveway that has been abandoned shall be restored by the property owner to previous conditions but at a minimum shall include obliteration of the opening such that the edge of the roadway or curb and gutter is connected on both sides of the opening being abandoned.

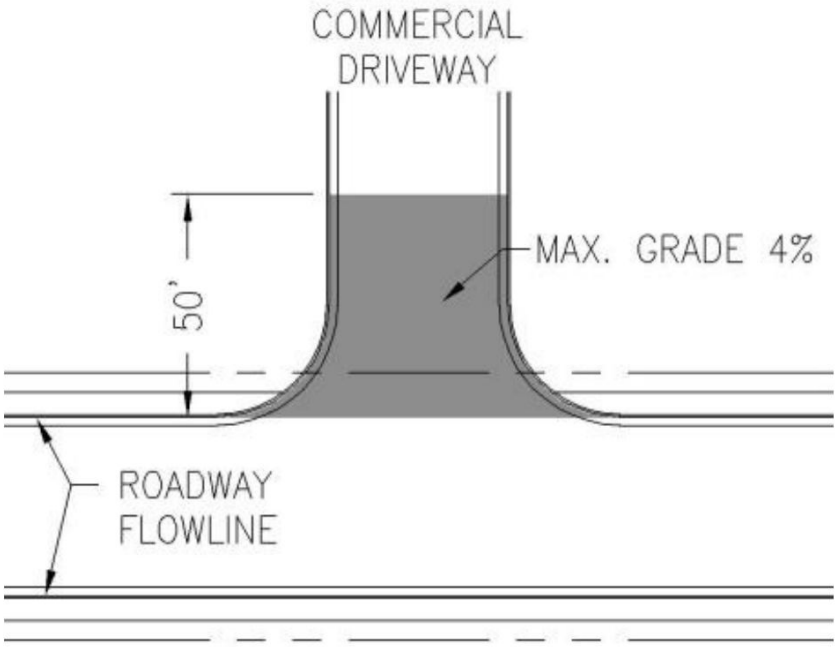
If the driveway is to serve only specific turning movements into and out of the property, the Owner or Developer will be required to provide some means of ensuring that motorists will use the driveway as designed. This is typically done using a raised median in the through street. If access is limited at the driveway location (right-in/ right-out or three-quarters movement), the island design shall follow American Association of State Highway and Transportation Officials (AASHTO) design criteria.

The City may limit or modify access points if concerns arise related to congestion or safety, or if road improvements necessitate removal or modification of raised median islands.

The length of the maximum grade of 4% along the centerline for a commercial driveway shall be a minimum of 50 feet measured from the flowline intersection of the roadway.

Figure 5-6 illustrates the maximum grade for a commercial driveway.

Figure 5-6. Commercial Driveway Maximum Grade



5.4 General Requirements

5.4.1 Number of Driveway Openings

Single-Family Residential – Single-family residential property shall be limited to one access point.

Multifamily Residential, Commercial and Industrial – If located on a Commercial and Industrial, Major Collector or Minor Collector roadway, assume the driveway functions as a Local Street and use the information provided on Figure 5-6. If access is located on a roadway classified other than Commercial and Industrial, driveway openings shall be determined on a case-by-case basis.

5.4.2 Driveway Entrance Angle

The driveway entrance angle for all approaches shall be 90 degrees, plus or minus 10 degrees, to the centerline of the street. Refer to Figure 7-25.

5.4.3 Joint Driveway Access

Joint driveway access must be considered to serve two adjacent properties for Commercial and Industrial Developments. Joint driveway accesses are typically centered on the common property line, and cross-access easements are required. These easements must be obtained by the property owners, and any related documentation shall be submitted with the access Permit.

5.4.4 Minimum Space Between Driveway Openings

If Joint Access is not used, the minimum spacing between driveways shall be 50 feet, measured between the inside edges of the two adjacent driveways. New driveways shall align with existing driveways on opposite sides of the street or be offset as noted previously. This does not apply to single-family residential projects. Refer to Figure 5-7.

5.4.5 Driveway Movements

Projects shall be designed to prohibit backing maneuvers in the right-of-way. Driveways accessing roadways shall not allow parking within 50 feet from the edge of the adjacent road.

5.4.6 Change in Use or Traffic Volume

If the use changes or volume increases by 20% for an existing access to a City right-of-way, or if there is a change in the use or developed size of the property, a Permit and additional improvements may be required, or the access may be limited. Change in access or property use may include, but is not limited to, change in the amount or type of traffic, structural modifications, remodeling, change in type of business, expansion in existing business, change in zoning, or change in property division creating new parcels. Consult with the City to determine whether a Permit will be required.

5.4.7 Auxiliary Lanes (Acceleration/D eceleration Lanes)

See Chapter 7 of these Roadway Standards.

5.5 Access Design

5.5.1 Width of Driveway Opening

The total width of driveway openings for properties measured at the curb line for various Street Classifications shall be in conformance with Table 5-1.

Table 5-1. Width of Driveway Openings

Roadway Class	Residential		Commercial and Industrial (feet)
	Single Family (feet)	Multifamily (feet)	
Principal and Minor Arterials	N/A	38 (if allowed)	38 (if allowed)
Major and Minor Collectors	N/A	38	24 to 36
Local	16 to 30	38	24 to 36

Notes:

1. Driveway openings of 30 feet or more must be constructed as a radius curb return.
2. If a radius curb return is used, the width of the allowed driveway does not include the curb return radius.
3. The width of the driveway opening does not include the tapers. refer to Curb Opening detail in Appendix A.
4. The dimensions in Table 5-1 may need to be increased if a Traffic Impact Study accepted by the City indicates different vehicle types or volumes would require modification of the dimensions.

5.5.2 Driveway Edge Clearance

This clearance is the distance measured along the curb line from the nearest edge of the curb opening to a point where the property line is extended to the curb line. Refer to Figure 5-8.

Note: Joint access with adjoining property must be considered. Joint access shall be the only justification for eliminating the minimum edge clearance dimension.

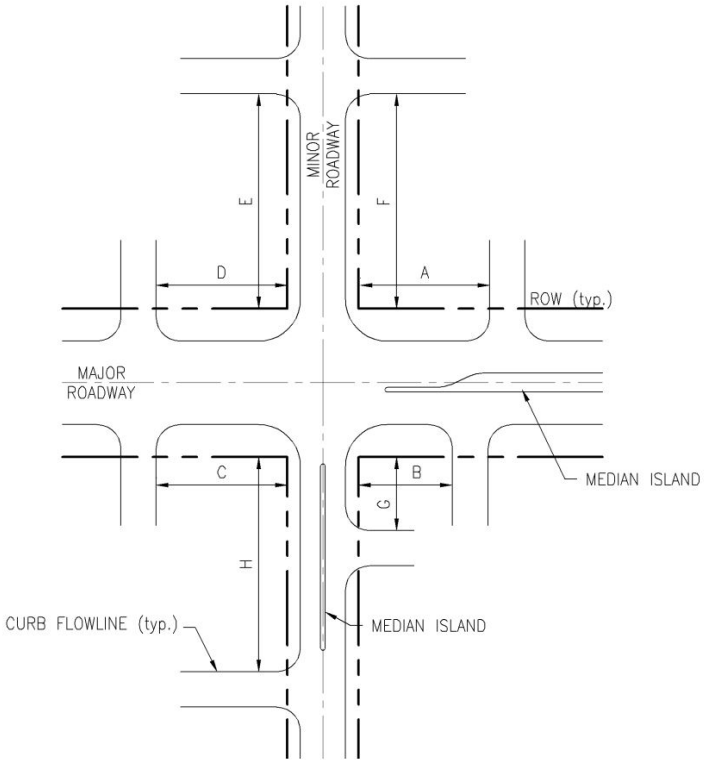
5.5.3 Corner Clearance

This clearance is the distance measured along the curb line from the nearest edge of the curb opening to the adjacent street right-of-way line. Refer to Figure 5-7.

Figure 5-7. Corner Clearances for Non-Single-Family Driveways

Minimum Corner Clearances			
Item	Class of Major Roadway		
	Arterial (feet)	Collector (feet)	Local (feet)
A	115	75	50
B	85	85	50
C	115	75	50
D	115	75	50
E	210	115	50
F	210	115	50
G	50	50	50
H	210	115	50

Note: This table does not apply to single-family residential driveways. Single-family residential driveways must access on the street of the lowest classification and at the side of the lot farthest away from the intersection.



Driveways should be located as far away from major intersections as possible. This constraint is as much for the ability to enter and leave the property as for the benefit of intersection safety and operations. Exiting a driveway during peak-hour conditions at traffic signals is difficult where the queue of standing or slow-moving vehicles does not allow a sufficient gap for entry from the driveway.

5.5.4 Sight Distance

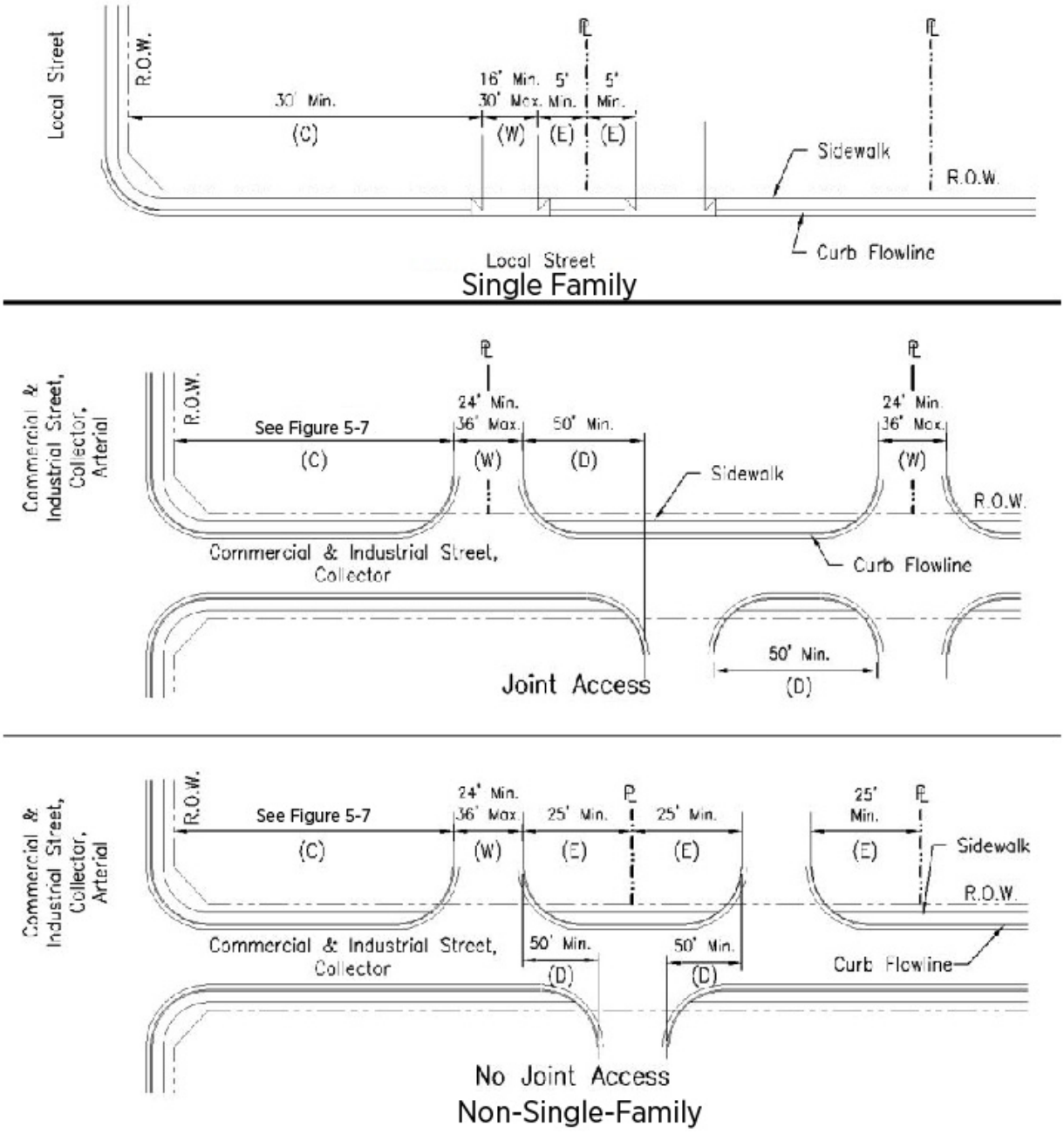
Sight distance for curb openings to private property shall consist of a sight triangle conforming to the requirements of these Roadway Standards.

5.6 Unpermitted Access

Any access, driveway, or curb cut constructed within public right-of-way without an access issued by the City or by an accepted site plan shall be subject to a Stop Work order and shall be removed immediately. Failure to obey the Stop Work order may result in the prosecution of the violators. Failure to remove the unapproved access may result in the removal of said access by the City, and the cost of removal shall be charged to the property owner from which the access originates. In the event the property owner fails to reimburse the City within 30 days after submission of the bill for the costs incurred, the City shall have the right to enforce such obligation by appropriate legal action.

Note: Single-family residential driveways must access on the street of the lowest classification and at the side of the lot farthest away from the intersection. Any deviations from these criteria require approval through the City. These dimensions only apply to the road classifications shown on Figure 5-8; if access is to a different classification of road, then intersection spacing shall apply.

Figure 5-8. Curb Openings and Driveway Spacing



Chapter 6 - Traffic Impact Study Criteria

6.1 Traffic Impact Studies

A Traffic Impact Study (TIS) may be required by the City to adequately assess the impacts of a development proposal on the existing or planned roadway network. A TIS shall be required for proposed developments with peak hour trip generation volumes anticipated to exceed 50 vehicles during any peak hour or when considered necessary or desirable by the City. The Applicant has the primary responsibility for assessing the traffic impacts associated with a proposed development, with the City serving in a review and approval capacity.

6.1.1 Standard TIS

The following scenarios or submittals shall require a TIS and thorough documentation of the study assumptions, process, and results:

1) Rezoning. If a rezoning is requested for a site, inclusive of major amendments to a planned development and use by special review applications, a Standard TIS may be required. In the case of a rezoning in which the currently proposed zoning is anticipated to generate fewer trips than the previously proposed zoning, a letter summarizing the trip generation of the application, including a comparison to the trip generation of the previously proposed zoning, may be submitted in lieu of a Standard TIS (refer to the Traffic Impact Study Compliance Letter subsection).
2) Preliminary Plan or Final Plat.
3) State Highway Access. A Colorado Department of Transportation (CDOT) access Permit is required for a new access from a new development, an additional access to an existing development, or a change in use for an existing access that abuts a state highway. CDOT will issue this access Permit even if the location is within Castle Pines city limits. Prior to submitting a request for an access Permit to CDOT, the TIS must be approved by the City.
4) Land Use Intensity Increase. The Applicant will be required to conduct a new TIS and submit documentation if, after submitting the original TIS for any of the previously noted scenarios, the land use intensity is increased by more than 20%, or the land use changes such that trip generation is increased by more than 20%.
5) Delayed Implementation. If development does not progress as anticipated, the Applicant may be required to update an existing TIS if the approved document is more than 2 years old, and the analysis years are no longer valid. This requirement will be waived if the City determines the conditions have not changed significantly.

A TIS conducted and documented to address one of these scenarios or submittals is referred to as a Standard TIS.

6.1.2 Scoping the TIS

The Applicant is strongly suggested to discuss projects with City staff prior to starting the TIS. The Applicant may request a meeting or phone conversation. Topics for discussion may include project phasing, trip generation, directional distribution of traffic, trip assignment, study area definition, intersections requiring capacity or level of service (LOS) analysis, analysis time periods, traffic safety analysis, truck traffic limitations, signal timing policies, and methods for projecting interim and buildout volumes as applicable.

Specific requirements will vary depending on the site location and development proposal. The TIS scope shall be commensurate with the scale and scope of probable operational and safety impacts to the general roadway network. A general guideline related to determining the extent of the study area is to extend the analysis at least as far as those areas where newly generated site traffic represents 5% or more of a roadway's peak hour capacity. Where site-generated traffic will be less than 5% of the roadway capacity, the study area limits would at minimum include all site accesses, adjacent roadways, and adjacent major intersections. At maximum, limits would also include all roadways, and Collector/ Collector and Collector/ Arterial intersections, extending from the proposed development to and including the intersection with the nearest state or federal highway. The study area or improvement commitments may extend into other jurisdictions or incorporated areas.

The TIS and its documentation will be the responsibility of the Applicant and must be prepared, stamped, and sealed by a Professional Engineer (PE) licensed in the State of Colorado with adequate experience in transportation engineering. Upon submission of a draft TIS, the City will review the study data sources, methods, and findings. Comments will be provided in a written form. The Applicant and PE will then have an opportunity to incorporate necessary revisions prior to submitting final documentation.

6.2 TIS Process and Document Format

To provide consistency and to facilitate staff review of a TIS document, the following format must be adhered to by the PE in the preparation of study documentation.

6.2.1 Executive Summary

The executive summary should briefly summarize the purpose of the TIS, its recommendations, and other information necessary for the City Development Review Engineer to understand the purpose of the TIS. If the subject study area was included in a previous TIS, an explanation must be included regarding how the subject area relates to the area previously analyzed. If necessary, explain any unusual circumstances that necessitate the TIS.

6.2.2 Introduction

Include the following items in the introduction section of the TIS document.

1) Development Site and Study Area Boundaries. Include a brief description of the land parcel size, existing uses, general terrain features, and location within the jurisdiction.
2) Study Area. The exact limits of the study area shall be based on sound engineering judgment and an understanding of existing traffic conditions surrounding the site. In all instances, however, the Applicant, PE, and City must mutually agree upon the study area limits. These limits will usually result from initial discussions with staff.
3) Vicinity Map. Include a Vicinity Map that shows the site and study area boundaries in relation to the surrounding transportation system. The map shall include proposed site access locations to the adjacent roadway network within the transportation system.
4) Proposed Development Description. Identify the proposed land use types(s) and size(s) in terms specific enough to align with land use codes contained in trip generation methodology. If the development is to be built in a phased manner, the types and sizes of the land use to be implemented in each phase, as well as the projected completion date of each phase, shall be identified. If specific land uses are not known, assume the most intense use (in terms of trip generation) allowed by current or proposed zoning. Include a figure that depicts the site plan, land uses within the site, and site access points to the adjacent roadway network.

5) TIS Scope. Briefly describe the agreed-upon scope of the TIS in terms of the study intersections, driveways, roadway segments, analysis time periods, and future scenarios to be analyzed.

6) Analysis Methodology. Explain the methodology followed to estimate the traffic operations within the study area. Assumptions, adjustment factors, data, and references must be described where applicable throughout the document to assist the City Development Review Engineer with understanding the methodology and process followed by the PE to conduct the TIS.

6.2.3 Existing Conditions

The current traffic conditions within the study area must be identified. The existing year will be determined during the initial meeting with the City but will typically be the year in which traffic volumes are collected. Include the following items in the TIS analysis and documentation of existing conditions.

1) Roadway Network. Describe existing roadways and intersections, including roadway classification, speed limits, geometrics, traffic control, and other pertinent features within the study area. Provide a figure that depicts the roadways and intersections, as well as surrounding land use and zoning.

2) Traffic Volumes. Collect current traffic volumes at identified intersections (turning movements) and roadway links (24-hour volume counts) for the study time periods. At a minimum, weekday morning (a.m.) and evening (p.m.) peak period turning movement counts will be required. Turning movement volumes for other periods may be required; these periods will be determined at the initial meeting. Traffic volumes over 2 years old are not acceptable. Include a graphic showing these daily and peak period volumes. All raw traffic count data (including average daily traffic volumes and peak hour turning movements) shall be included in appendices to the TIS documentation.

3) Levels of Service (LOS). The current traffic operations within the study area shall be described in terms of LOS during the analysis time periods, using the operational methodologies as detailed in the most recent version of the Highway Capacity Manual (HCM). The City will provide existing traffic signal timing values. For signalized intersections, LOS shall be reported for each individual movement and for the intersection overall in each analysis time period. For unsignalized intersections, LOS shall be reported for each applicable individual movement in each analysis time period. The extent of vehicle queuing and its potential impact to adjacent intersections shall be evaluated using a Poisson's distribution methodology (see Queuing Analysis section) or other method approved by the City.

   Include a narrative explanation of the LOS results and the impact to area traffic operations. Existing traffic volumes and LOS shall be shown in graphical format for each analysis time period. For signalized intersections, the graphic should show overall intersection LOS. For unsignalized intersections, the graphic should show LOS for each applicable movement. All LOS output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

4) Traffic Safety Analysis. The City will indicate during the initial meeting whether a traffic safety analysis will be required for inclusion in the TIS. The analysis scope will be determined during the initial meeting, but the minimum requirement will be an analysis of traffic crash data for roadway corridors affected by the proposed development to identify historical crash issues and estimate how turning movements and conflict points introduced by new site accesses may impact crash potential. The safety analysis period will normally be the most recent 3 years.

6.2.4 Future Background Conditions

Background traffic volumes for intersections and roadways within the study area must be determined for the opening year of the proposed development (short term) and for the 20-year or area buildout planning horizon (long term) without influence of the proposed site, as determined by the City. Area buildout will typically coincide with the year of the currently approved regional travel demand model. These volumes

shall be used to project background traffic operating conditions. For phased developments, analysis of interim horizons coincident with completion of additional phases may be required. Include the following items in the TIS analysis and documentation of background conditions:

1) Approved Developments. Projected traffic volumes for platted/ approved but unbuilt developments within the study area, or having impact on the study area, shall be added to the projected volumes for the appropriate planning horizon. These volumes shall be based on the expected buildout proportion of the approved plat(s) coincident with the subject planning horizon. Typically, this will primarily affect the background traffic at the time of the opening of the proposed development; however, traffic generated by some larger approved projects may not impact the area until after opening year of the subject development. This projected, post-opening year traffic must be added into the 20-year or area buildout planning horizon.

2) General Growth. In addition to approved developments, regional traffic growth will affect background traffic volumes for opening, interim, and horizon analysis scenarios. Future traffic growth shall be developed through means determined appropriate by the City, such as the City of Castle Pines Transportation Master Plan, growth rate methodology, and regional travel demand model estimates. The City will determine whether proposed general traffic growth rates are acceptable.

3) Currently Planned Roadway Improvements. Roadway improvements that would impact traffic conditions within the study area and that are currently planned and funded shall be included in the analysis of future background conditions, as appropriate. Explain the nature of the improvement project, its geographical limits, implementation schedule, funding source and responsible agency/ entity.

4) Level of Service. The background traffic LOS within the study area, without influence of the proposed site, shall be assessed in each analysis time period for each of the identified study years. The LOS shall be analyzed using the operational methodologies as detailed in the most recent version of the HCM. Signalized intersection analysis must use a cycle length consistent with current City signal timing policies. For signalized intersections, LOS shall be reported for each individual movement and for the intersection overall in each analysis time period. For unsignalized intersections, LOS shall be reported for each applicable individual movement in each analysis time period. The extent of vehicle queuing and its potential impact to adjacent intersections shall be evaluated using a Poisson's distribution methodology (see Queuing Analysis section) or other method approved by the City.

   Include a narrative explanation of the LOS results. Background traffic volumes and LOS shall be shown in graphical format for each analysis time period. For signalized intersections, the graphic should show overall intersection LOS. For unsignalized intersections, the graphic should show LOS for each applicable movement. All LOS output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

6.2.5 Site Traffic/ Trip Projections

This section shall include a summary table listing type, size, the Institute of Transportation Engineers (ITE) Trip Generation – Land Use Code for each land use in the development, trip generation rates, and the resultant total trips for each analysis time period. Trip generation rates from the most current ITE Trip Generation manual shall be used. If an ITE Land Use Code for the proposed land use is unavailable, trip generation from similar land uses, either from other sources, jurisdictions, or field studies, may be used with City approval. If the proposed development will serve an atypically high proportion of heavy vehicles, passenger car equivalents shall be determined and used to estimate trip generation. For phased developments, provide trip generation for each phase individually and for the whole development at buildout.

Site Trip Reductions. Use of the following types of trip reduction factors may be considered with City approval:

1) Pass-by factors. As published in the current ITE Trip Generation Manual, pass-by factors can be used to reduce the projected additional total daily traffic to roadways adjacent to a proposed development. These factors shall not be applied directly to reduce trip generation and turning movement volumes at driveways serving the proposed development.
2) Internal capture. Trip reductions may be used to reduce the peak period and daily trip generation estimates for a mixed-use development. Assumptions must be documented.
3) Modal split. Trips may be reduced when appropriate, such as when the proposed development is located in a transit-oriented development or within one-quarter mile of a major transit corridor. Assumptions must be documented.

Site Trip Distribution. The estimates of percentage distribution of trips from the proposed development to destinations in the region must be clearly stated in this section, using the north, south, east, and west compass points. Trip distribution should be based on actual traffic data where possible. Market studies and information concerning origin of trip attractions to the proposed development may be used to support these assumptions where available. Likewise, distributions presented in TIS documents recently approved by the City may be a source for assumptions. The percentage of site traffic on each roadway must be included in tabular or graphical format to support the textual discussion of the trip distribution assumptions.

Traffic Assignment. The allocation of site-generated traffic along the area's roadway network and through the site access points must be presented in this section. The technical analysis steps, basic methods, and assumptions used in this work shall be clearly documented and follow the assumptions agreed to by the City. The assumed trip distribution and assignment must represent the most logically traveled routes for drivers accessing the proposed development. These routes can be determined by observation of travel patterns to existing land uses in the study area. A graphic showing the site traffic assignment on the surrounding roadway network must be included for each analysis time period.

6.2.6 Projected Site Traffic Impacts

Traffic impacts of the proposed development shall be analyzed for all time periods in the anticipated opening year, interim project phases, and the identified planning horizon. Include the following items in the TIS analysis and documentation of total conditions for short-term (site opening), interim phases, and long-term horizons. LOS values shall be tabulated in a single table for all study intersections, analyzed time periods, and analysis scenarios. All LOS output reports shall be included in the appendices, and electronic data files must accompany the TIS submittals.

6.2.6.1 Site Opening Year for Single-Phase Developments

1) Total Traffic. The total projected traffic volumes at the day of development completion shall be determined by adding the proposed site-generated traffic to the short-term background traffic.
2) Level of Service. The total traffic LOS within the study area at development completion shall be assessed for each analysis time period. The LOS shall be analyzed using the operational methodologies as detailed in the most recent version of the HCM. Signalized intersection analysis must use a cycle length consistent with current City signal timing policies. For signalized intersections, LOS shall be reported for each individual movement and for the intersection overall in each analysis time period. For unsignalized intersections, LOS shall be reported for each applicable individual movement in each analysis time period. The extent of vehicle queuing and its potential impact to

adjacent intersections shall be evaluated using a Poisson's distribution methodology (see Queuing Analysis section) or other method approved by the City.

For signalized intersections and proposed roadway segments, LOS D for each movement and for the intersection overall will be the design objective at development opening. Under no circumstances shall the development cause a drop below LOS D at signalized intersections for individual movements and overall for any analysis scenario. Refer to the most recent version of the HCM for the average vehicular delays associated with each LOS letter designation.

Include a narrative explanation of the LOS results and the impact to area traffic operations. Opening-year traffic volumes and LOS shall be shown in graphical format for each analysis time period. For signalized intersections, the graphic should show overall intersection LOS. For unsignalized intersections, the graphic should show LOS for each applicable movement. All LOS output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

3) Mitigation. At study area intersections with projected LOS E or worse overall or for individual movements, mitigation measures shall be identified to improve intersection operations to an acceptable level. Mitigation measures shall also be identified for locations where LOS may be acceptable, but the analysis projects queuing issues with adjacent intersections. This section shall describe and present the results of the additional LOS analysis iterations conducted to identify the appropriate mitigation measures. If individual movements at unsignalized intersections are projected to operate below LOS D, include a discussion about possible mitigation measures or reasonable alternate routes.

   The graphical presentation of LOS should include the original and mitigated overall LOS for signalized intersections and by applicable movement for unsignalized intersections. This information can be added to the traffic volume and LOS graphic.

4) Sight-Distance Analysis. Include an analysis of available entering sight distance at all proposed site access points (per Chapter 7 of these Roadway Standards). This analysis shall include an assessment of the clear zone and horizontal and vertical sight distances. Future accesses identified for an adjacent development shall also be included as necessary if they are proximal to the subject site access.

5) Traffic Safety. If a traffic safety analysis was completed as part of the existing conditions identification, include a discussion of how the proposed site access points and trips generated by the project may impact or alter documented safety issues and operations at the site access points and study area intersections. Discuss potential safety strategies that are proven effective to address the identified issue(s).

6.2.6.2 Site Opening Years for Interim Phases

1) Total Traffic. The total projected traffic volumes at the day of development completion for each of multiple phases shall be determined by adding the proposed site-generated traffic to the applicable background traffic.

2) Level of Service. The total traffic LOS within the study area at each phase of completion shall be assessed for each analysis time period. The LOS shall be analyzed using the operational methodologies as detailed in the most recent version of the HCM. Signalized intersection analysis must use a cycle length consistent with current City signal timing policies. For signalized intersections, LOS shall be reported for each individual movement and for the intersection overall in each analysis time period. For unsignalized intersections, LOS shall be reported for each applicable individual movement in each analysis time period. The extent of vehicle queuing and its potential impact to

adjacent intersections shall be evaluated using a Poisson's distribution methodology (see Queuing Analysis section) or other method approved by the City.

For signalized intersections and proposed roadway segments, LOS D for each movement and for the intersection overall will be the design objective at development opening. Under no circumstances shall the development cause a drop below LOS D at signalized intersections for individual movements and overall for any analysis scenario.

Include a narrative explanation of the LOS results and the impact to area traffic operations. Interim-year traffic volumes and LOS shall be shown in graphical format for each analysis time period. For signalized intersections, the graphic should show overall intersection LOS. For unsignalized intersections, the graphic should show LOS for each applicable movement. All LOS output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

3) Mitigation. At study area intersections with projected LOS E or worse overall or for individual movements, mitigation measures shall be identified to improve intersection operations to an acceptable level. Mitigation measures shall also be identified for locations where LOS may be acceptable, but the analysis projects queuing issues with adjacent intersections. This section shall describe and present the results of the additional LOS analysis iterations conducted to identify the appropriate mitigation measures. If individual movements at unsignalized intersections are projected to operate below LOS D, include a discussion about possible mitigation measures or reasonable alternate routes.

   The graphical presentation of LOS should include the original and mitigated overall LOS for signalized intersections and by applicable movement for unsignalized intersections. This information can be added to the traffic volume and LOS graphic.

4) Sight-Distance Analysis. A sight-distance analysis shall be included for each phase if any geometric conditions will have changed from those assessed for the Single-Phase development. For example, an additional intersection or driveway is planned to be added near a study area intersection, or signing/ landscaping is planned to be installed in a lot adjacent to a site access.

5) Traffic Safety. A traffic safety analysis shall be included for each phase if any conditions will have changed from those assessed for the Single-Phase development.

6.2.6.3 Long-Term Planning Horizon

1) Total Traffic. The total projected traffic volume at the long-term horizon year shall be determined by adding the proposed site-generated traffic at buildout to the long-term background traffic.

2) Level of Service. The total traffic LOS within the study area at the horizon year shall be assessed for each analysis time period. The LOS shall be analyzed using the operational methodologies as detailed in the most recent version of the HCM. Signalized intersection analysis must use a cycle length consistent with current City signal timing policies. For signalized intersections, LOS shall be reported for each individual movement and for the intersection overall in each analysis time period. For unsignalized intersections, LOS shall be reported for each applicable individual movement in each analysis time period. The extent of vehicle queuing and its potential impact to adjacent intersections shall be evaluated using a Poisson's distribution methodology (see Queuing Analysis section) or other method approved by the City.

   For signalized intersections and proposed roadway segments, LOS D for each movement and for the intersection overall will be the design objective at development opening. Under no circumstances

shall the development cause a drop below LOS D at signalized intersections for individual movements and overall for any analysis scenario.

Include a narrative explanation of the LOS results and the impact to area traffic operations. Horizon-year traffic volumes and LOS shall be shown in graphical format for each analysis time period. For signalized intersections, the graphic should show overall intersection LOS. For unsignalized intersections, the graphic should show LOS for each applicable movement. All LOS output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

3) Mitigation. At study area intersections with projected LOS E or worse overall or for individual movements at signalized intersections, mitigation measures shall be identified to improve intersection operations to an acceptable level. Mitigation measures shall also be identified for locations where LOS may be acceptable, but the analysis projects queuing issues with adjacent intersections. This section shall describe and present the results of the additional LOS analysis iterations conducted to identify the appropriate mitigation measures. If individual movements at unsignalized intersections are projected to operate below LOS D, include a discussion about possible mitigation measures or reasonable alternate routes.

   The graphical presentation of LOS should include the original and mitigated overall LOS for signalized intersections and by applicable movement for unsignalized intersections. This information can be added to the traffic volume and LOS graphic.

4) Sight Distance Analysis. A sight-distance analysis shall be included for the horizon year if any geometric conditions will have changed from those assessed for the single or interim phases. For example, an additional intersection or driveway is planned to be added near a study area intersection, or signing/ landscaping is planned to be installed in a lot adjacent to a site access.

5) Traffic Safety. A traffic safety analysis shall be included for the horizon year if any conditions will have changed from those assessed for the single or interim phases.

6.2.7 Potential Mitigation Measures

Recommendations for potential mitigation measures, including new roadways, additional traffic lanes on existing roadways, and changes to traffic control, must be approved by the City prior to finalizing the TIS documentation.

Roundabouts as Mitigation Measures. At intersections of two roadways that are projected to operate at an LOS below the City standard or warrant signalization, the City may require evaluation of a modern Roundabout as a mitigation measure. The evaluation shall use a software analysis program approved by the City.

Traffic Signals as Mitigation Measures. Approval of new traffic signals will be based in part on warrants contained in the Manual on Uniform Traffic Control Devices (MUTCD) and any additional warrants established by the National Committee on Uniform Traffic Control Devices. In determining the location of a new signal, traffic progression is of paramount importance. Generally, a spacing of one-half mile for all signalized intersections should be maintained. This spacing is usually desirable to achieve good speed, capacity, and optimum signal progression. Pedestrian movements must be considered in the evaluation and adequate pedestrian clearance provided in the signal cycle split assumptions.

To provide flexibility and optimum two-way signal progression, a signal-progression analysis must be conducted that includes all proposed accesses that may require signalization. The section of roadway to be

analyzed for signal progression will be determined by the City and will include all existing and possible future signalized intersections.

The progression pattern calculations must use a cycle length consistent with the City's current signal timing policies. A desirable bandwidth of 50% of the signal cycle should be used where existing conditions allow. At currently unsignalized intersections that are expected to be signalized in the future, a 60% mainline and 40% cross-street cycle split should be assumed. Cycle split assumptions must relate to volume assumptions in the capacity analysis of individual intersections and consider pedestrian clearance times in the development of time/space diagrams. Document the progression analysis assumptions and results in a separate section of the TIS documentation.

The green time allocated to the cross street shall be no less than the time required for a pedestrian to clear the main street using MUTCD standards. Those intersections that would reduce the optimum bandwidth if a traffic signal were installed may be required to remain unsignalized and have turning movements limited by access design or median islands. Refer to Section 3 of the State Highway Access Code for signal spacing on state highways.

6.2.8 Queuing Analysis

A 95th percentile (using Poisson's distribution) queue length will be used to verify the adequacy of existing storage lengths and as the basis of storage length design for the long-term planning horizon. Alternative methodologies, such as Synchro 95th percentile length calculations, may be used with City approval. The queuing calculations must use a cycle length consistent with the City's current signal timing policies. Green times for specific movements shall be based on the movement's proportion of the critical lane volume, subject to phase minimums. Minimum greens shall be assumed to be 10 seconds for through movements and 4 seconds for left turns. Yellow change and red clearance intervals shall be assumed to be 3 seconds and 2 seconds, respectively, for left turn movements; 4 seconds and 2 seconds, respectively, for through movements. For lane groups that have multiple lanes, a lane utilization factor, in accordance with the HCM methodology, shall be applied to the calculation of queue lengths.

The queuing analysis results may be discussed concurrently with the LOS discussions for each analysis scenario or may be discussed in a separate section of the TIS documentation. Provide a table that summarizes the projected 95th percentile queue lengths by movement and recommended storage lane lengths. All queuing output reports shall be included in an appendix to the TIS document. Electronic data files must accompany the TIS document submittal.

6.2.9 Conclusions and Recommendations

This section summarizes the proposed development and presents the TIS findings to include:

1) Identified Improvements. Describe the location, nature, timing, and extent of proposed improvements that would be necessary to provide sufficient roadway and intersection capacity at design objective LOS. Provide a graphic of the improvements showing length, width, and other pertinent geometric features of the proposed improvements. Include the year at which the improvement must be in place to provide the objective LOS and indicate the party responsible for funding or implementing the improvements.
2) Access Spacing Assessment. Describe the spacing between proposed site access points and existing or approved future access points. Indicate whether the proposed access points comply with applicable City or State minimum spacing requirements. If a variance is requested, provide justification for approval of the variance.

3) Site-Generated Traffic Volume Proportion. Percentage estimates may be required by the City to identify the proportion of site-generated trips that will travel on various public improvements (both existing and proposed) such as signalization, roads, and bridges. This calculation shall be based on daily volumes and shall include background traffic growth along with trip generation from other developments whose traffic travels on the same improvements. Fair share percentage calculations shall be based on the trip generation and not a percentage of the total (growth plus site) traffic.

6.3 TIS Revisions

The Applicant must incorporate revisions to the TIS as required by the City. The need to require revisions will be based on the completeness of the TIS documentation, the thoroughness of the impact evaluation, the adequacy of proposed improvements and mitigation measures, and the compatibility of the TIS recommendations with the proposed access and development plan. The Applicant may discuss comments with the City reviewer prior to initiating the revisions. The TIS document will not be approved until all reviewer comments have been addressed to the City's satisfaction.

6.4 Traffic Impact Study Compliance Letter

An approved Standard TIS for a development that has been master planned may be used as reference for further planning of individual lots or subareas. The required TIS for subareas may take the form of a TIS Compliance Letter. If agreed to during the initial meeting with the City, the Applicant may submit a Compliance Letter confirming that the anticipated subarea traffic impacts are similar to or less than those projected in the Standard TIS. The City may also require additional information beyond the Compliance Letter.

6.4.1 Compliance Letter Qualifying Conditions

A TIS Compliance Letter may be considered if the following conditions are met:

1) A Standard TIS for the area has been completed and approved by the City.
2) Total projected trip generation (in accordance with the ITE Trip Generation Manual methodology) for the lot or subarea is less than or equal to the buildout scenario assumptions in the Standard TIS.
3) Trip distribution is expected to be similar to that projected in the Standard TIS.
4) Access to the lot or subarea is the same as proposed in the Standard TIS.

6.4.2 Submittal of a Compliance Letter

The Applicant must include the following information, at a minimum, in a letter prepared, stamped, and signed by a PE licensed in the State of Colorado:

1) Introduction/ Project Description
    a) Discussion of reason for submitting letter
    b) *Figure:* Vicinity Map
    c) *Figure:* Proposed Development Site Plan
2) Proposed Conditions
    a) Discussion of proposed land use and ITE trip generation land use code
    b) *Table:* Trip Generation Summary

c) *Table:* Comparison of Trip Generation for Uses in Standard TIS to Trip Generation for Proposed Site Uses

d) Discussion of comparison between Standard TIS trip generation and proposed trip generation

3) Conclusions/Recommendations

a) Compare/contrast Standard TIS with proposed development

b) Finding of no significant change to projected site attributes, including

i) Operations

ii) Access

iii) Parcel layout

iv) Developer commitments to implementing improvements

4) Appendix

a) Cover page of Standard TIS

b) Conclusion page(s) of Standard TIS

c) *Figure:* Master Site Plan

Chapter 7 - Public and Private Roadway Criteria

7.1 General

Chapter 7 sets forth the **minimum** design, technical criteria, and specifications to be used in the preparation of all roadway plans.

These Roadway Standards are for new construction and modification to existing infrastructure. Modifications and additions to existing infrastructure shall comply with these Roadway Standards to the maximum extent practicable.

7.2 Roadway Design and Technical Criteria

The City Public Works Department has adopted a Functional Street Classification Plan based on projected traffic volumes, land use, and expected growth. This Functional Street Classification Plan designates streets as follows:

- Cul-de-Sac (Local with specific design criteria in accordance with Section 7.3.2)
- Local (Section 7.3.3)
- Entry Street (Local with specific design criteria in accordance with Section 7.3.4)
- Commercial and Industrial (Local with specific design criteria in accordance with Section 7.3.5)
- Major or Minor Collector (Section 7.3.6)
- Minor or Principal Arterial (2- and 4-Lane) (Sections 7.3.7 and 7.3.8)

The projected traffic volumes shall determine the street classifications. The extent of right-of- way widening and improvements at intersections and on the approaches to intersections shall be determined by these Roadway Standards, a Traffic Impact Study, and the City Public Works Department.

Basic considerations in the design of circulation systems must recognize the following factors:

- Safety – for both vehicular and pedestrian traffic
- Efficiency of Service – for all users
- Livability – especially as affected by traffic elements in the circulation system
- Economy – of both construction and use of land

Each of the following principles is an elaboration on one or more of these four factors. The principles are not intended as absolute criteria, because instances may occur where certain principles conflict. The principles should, therefore, be used as guidelines for proper system layout.

- Enable vehicular and pedestrian access
- Minimize through trips
- Minimize or control access to Arterials
- Discourage speeding
- Minimize pedestrian-vehicular conflicts
- Relate street to topography
- Provide parking where applicable
- Increase lifecycle or reduce road maintenance costs

Table 7-1. Summary of Roadway Construction Standards

Criteria	Local		Local Special Use	
	Cul-de-Sac	Local	Entry Street	Commercial and Industrial
Posted Speed (mph)	25	25	25	25
Design Speed (mph)	25	30	30	30
Maximum Design Traffic Volume (Vehicles per Day)	400	1,500	1,500	2,500
Min. Right-of-Way (feet)	50 SF 60 MF	50 SF 60 MF	60 70 for Median	60
Travel Lanes	2	2	2	2
Curb and Walks	SF– Mountable with 4-foot walk	SF– Mountable with 4-foot walk	Vertical curb with 5-foot walk	Vertical curb with 5-foot walk
	MF – Vertical with 5-foot walk	MF – Vertical with 5-foot walk		
Street Sections	SF– 30-foot paved width, two 2-foot gutter pans, total is 34-foot FL to FL	SF-30-foot paved width, two 2-foot gutter pans, total is 34-foot FL to FL	36-foot paved width, two 2-foot gutter pans, total is 40-foot FL to FL	36-foot paved width, two 2-foot gutter pans, total is 40-foot FL to FL
	MF – 34-foot paved width, two 2-foot gutter pans, total is 38-foot FL to FL	MF – 34-foot paved width, two 2-foot gutter pans, total is 38-foot FL to FL	34-foot paved, 16-foot median, two 1-foot median pans, two 2-foot gutter pans, total is 56-foot FL to FL	
Horizontal Criteria				
Min. Centerline Curve Radii (feet)	175	225	225	225
Curb Return Radii @ Arterial (feet)	N/A	N/A	35	N/A
Curb Return Radii @ Collector (feet)	35	35	35	35
Curb Return Radii @ Local (feet)	20 to 25	20 to 25	20 to 25	N/A
Vertical Criteria				
K-Value Crest	19	19	19	19
K-Value Sag	26	37	37	37
Min. VCL Crest (feet)	50	50	50	50
Min. VCL Sag (feet)	50	50	50	50

Table 7-1. Summary of Roadway Construction Standards

Criteria	Local		Local Special Use	
	Cul-de-Sac	Local	Entry Street	Commercial and Industrial
Vertical Gradient	1% to 6% 7% Mountainous	1% to 6% 7% Mountainous	1% to 6% 7% Mountainous	1% to 6% 7% Mountainous
Max Int. Gradient	Refer to Figure 7-21	Refer to Figure 7-21	Refer to Figure 7-21	Refer to Figure 7-21

Mountainous terrain applies to developments where 50 percent of the site has existing slopes of 15% or greater. The designer should strive to minimize the use of these grades for considerable lengths and on north-facing slopes.

All curves with a K-Value higher than 167 need special review for drainage issues.

Roadway grades over 6% must have special permission from the applicable Fire District.

Notes:

FL to FL = flowline to flowline
MF = multifamily
mph = mile(s) per hour
N/A = not applicable
SF = single-family

Table 7-1. Summary of Roadway Construction Standards (continued)

Criteria	Collector	Arterial	
	Major and Minor Collector	Minor Arterial	Principal Arterial
Posted Speed (mph)	30	40 Minimum	40 Minimum
Design Speed (mph)	45	55	60
Maximum Design Traffic Volume (Vehicles per Day)	7,000	15,000	15,000
Min. Right-of-Way (feet)	60	125	140
Travel Lanes	2	4	4
Street Sections	34-foot paved width, two 2-foot gutter pans, total is 38-foot FL to FL	48-foot paved, 16-foot median, two 1-foot median pans, two 2-foot gutter pans, total is 70-foot FL to FL	48-foot paved, 28-foot median, two 1-foot median pans, two 2-foot gutter pans, total is 82-foot FL to FL
Curb and Walks	Vertical curb and 5-foot detached walk	Vertical curb and 10-foot detached walk	Vertical curb and 10-foot detached walk
Horizontal Criteria			
Min. Centerline Curve Radii (feet)	700	1,200	1,500
Curb Return Radii @ Arterial (feet)	50	50	50
Curb Return Radii @ Collector (feet)	35	50	50

Table 7-1. Summary of Roadway Construction Standards (continued)

Criteria	Collector	Arterial	
	Major and Minor Collector	Minor Arterial	Principal Arterial
Curb Return Radii @ Local (feet)	35	N/A	N/A
Vertical Criteria			
K-Value Crest	29	84	84
K-Value Sag	49	96	96
Min. VCL Crest (feet)	50	70	110
Min. VCL Sag (feet)	50	60	90
Vertical Gradient	2% to 6%; 7% Mountainous	2% to 6%	2% to 6%
Max Int. Gradient	Refer to Figure 7-21	Refer to Figure 7-21	Refer to Figure 7-21

Mountainous terrain applies to developments where 50% of the site has existing slopes of 15% or greater. The designer should strive to minimize the use of these grades for considerable lengths and on north-facing slopes.

All curves with a K-Value higher than 167 need special review for drainage issues.

Roadway grades over 6% must have special permission from applicable Fire District.

Design volumes shown in Table 7-1 are for the purpose of development design and layout and to project vehicular usage. Actual volumes on the street depend on existing conditions, future changes in traffic patterns, and transportation trends.

7.3 Engineering Design and Technical Criteria

7.3.1 Right-of-Way

Any increase in right-of-way width shall be made at intersections only. The line-of-sight shall be within the public right-of-way (see Sight Distance in this Chapter). The right-of-way line behind curb returns shall be a diagonal line (see Standard Drawing No. SD.4a and SD.4b in Appendix A).

Certain circumstances related, but not limited to, line of sight, traffic control devices, and pedestrian improvements may require additional rights-of-way, resulting in site-specific adjustment in the location of the right-of-way line behind a curb return. See right-of-way requirements under each road type section.

7.3.2 Cul-de-Sac

A Cul-de-Sac has no outlet and includes a Turnaround area at the end of the street. A Cul-de-Sac may have a maximum length of 1,200 feet and a maximum of 40 dwelling units, and the street section shall include two driving lanes plus parallel parking on both sides of the street.

Posted Speed Limit	25 mph
Design Speed Limit	25 mph
Traffic Volumes	Maximum Design Volume is generally 400 vehicles per day.
Continuity	Limited

Right-of-Way	Single Family – 50-foot minimum Multifamily – 60-foot minimum
Traffic Control	Signage and pavement markings are in accordance with *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) and Chapter 9 of these Roadway Standards.
Number of Travel Lanes	2
Type of Curb, Gutter, and Walk	Single Family – 4-inch mountable curb with 4-foot attached walk – both sides of street Multifamily – 6-inch vertical curb with 5-foot attached walk – both sides of street.
Turnarounds	Minimum 45-foot flowline radius
Knuckles	45-foot flowline radius on the inside and outside flowlines.
Eyebrows	Eyebrows shall have a 45-foot flowline radius, and a 25-foot curb return radius.
Street Section	Single Family – 34 feet, flowline to flowline. Multifamily – 38 feet, flowline to flowline. See Standard Section.
Street Grade	1% to 6%; 7% Mountainous
Minimum Centerline Curve Radii	175 feet
Curb Return Radii @ Arterial	N/A
Curb Return Radii @ Collector	35 feet
Curb Return Radii @ Local	20 to 25 feet
K-Value Crest	19
K-Value Sag	26
Minimum VCL Crest	50 feet
Minimum VCL Sag	50 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.2.1 Function

Cul-de-Sacs provide direct access to abutting property. Traffic carried by cul-de- sacsshould have an origin or a destination within the neighborhood.

7.3.2.2 Access Conditions

Cul-de-Sacs shall only intersect with other Cul-de-Sacs, Local, and Minor Collector streets. Direct access to abutting property is permitted. Cul-de-Sacs shall not intersect Principal Arterial, Minor Arterial, or Major Collector streets. Refer to Chapter 5 of these Roadway Standards.

7.3.2.3 Design Characteristics

A Cul-de-Sachas no outlet and includes a Turnaround area (refer to Figure 7-13, Turnarounds) at the end of the street. A Cul-de-Sacmay have a maximum length of 1,200 feet and a maximum of 40 dwelling units. When aCul-de-Sacis longer than 600 feet, or has more than 25 dwelling units, sprinklers in units may be required in accordance with the National Fire Protection Association. The street section shall

include two through lanes plus parallel parking on one side of the street for single-family developments and on both sides of the street for multifamily developments (Figures 7-1 and 7-2).

Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4, Utility Locations, of these Roadway Standards.

7.3.2.4 Street Section

Figure 7-1. Cul-de-Sac: Single Family

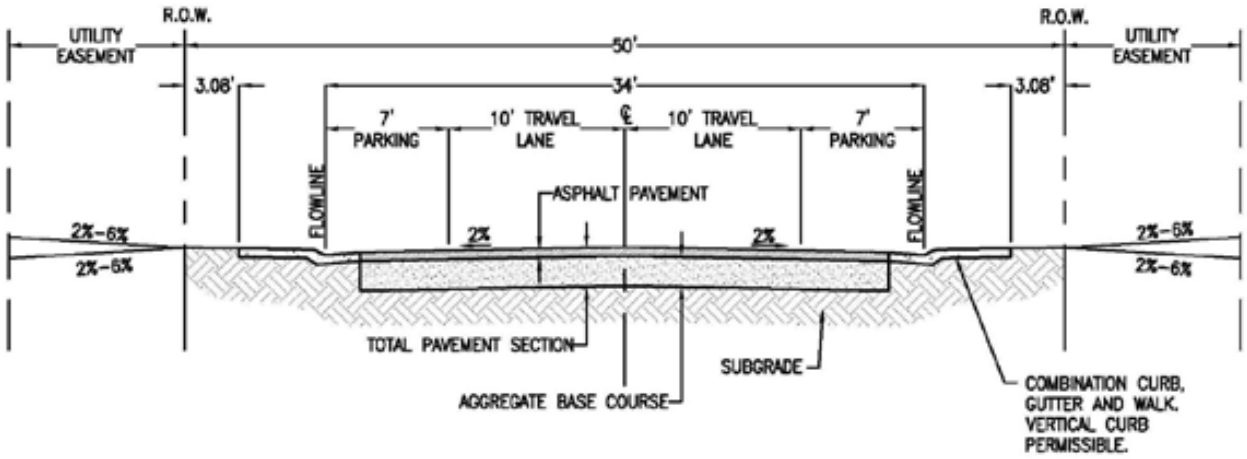
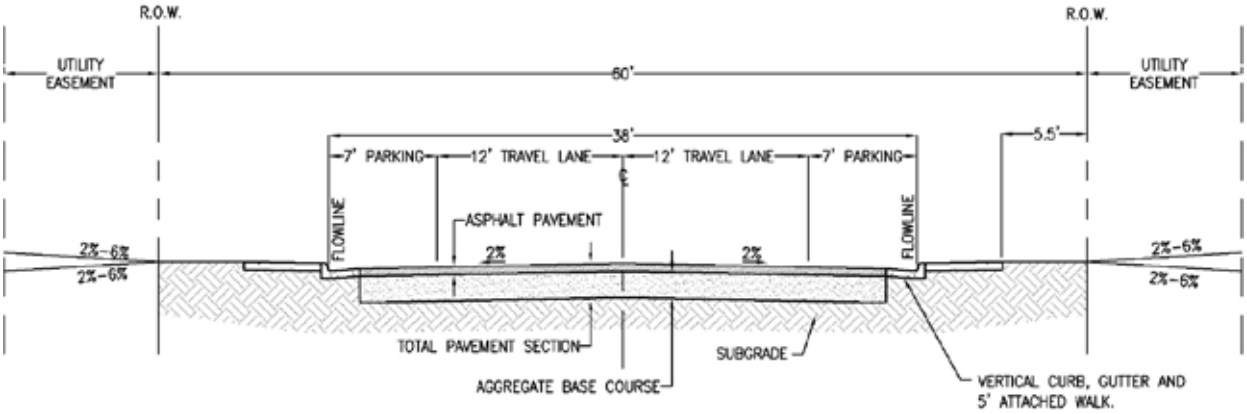


Figure 7-2. Cul-de-Sac: Multifamily



7.3.3 Local

A Local road may be used for all residential land development. The street section shall include two driving lanes plus parallel parking on both sides of the street. Entry, School Access, Commercial, and Industrial street classifications are considered local roads but have different requirements, as noted in Sections 7.3.4 and 7.3.5.

Posted Speed Limit	25 mph
Design Speed Limit	30 mph
Traffic Volumes	Maximum Design Volume is generally 1,500 vehicles per day. (Typically, capacity up to 2,500 vehicles per day is considered to be acceptable in fully established communities)

Continuity	Limited
Right-of-Way	Single Family – 50-foot minimum Multifamily – 60-foot minimum
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	2
Type of Curb, Gutter, and Walk	Single Family – 4-inch mountable curb with 4-foot attached walk – both sides of street Multifamily – 6-inch vertical curb with 5-foot attached walk – both sides of street
Turnarounds	Not allowed
Knuckles	45-foot flowline radius on the inside and outside flow lines
Eyebrows	45-foot flowline radius, and a 25-foot curb return radius
Street Section	Single Family – 34 feet, flowline to flowline Multifamily – 38 feet, flowline to flowline
Street Grades	1% to 6%; 7% Mountainous
Minimum Centerline Curve Radii	225 feet
Curb Return Radii @ Arterial	N/A
Curb Return Radii @ Collector	35 feet
Curb Return Radii @ Local	20 to 25 feet
K-Value Crest	19
K-Value Sag	37
Minimum VCL Crest	50 feet
Minimum VCL Sag	50 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.3.1 Function

Local streets provide direct access to abutting property. Traffic carried by Local streets should have an origin or a destination within the neighborhood.

7.3.3.2 Access Conditions

Local roads shall only intersect with Local and Minor or Major Collector roads. Direct access to abutting property is permitted. Local streets shall not intersect Principal or Minor Arterial streets. See Chapter 5 of these Roadway Standards.

7.3.3.3 Design Characteristics

Local streets shall be designed to carry traffic that has an origin or destination within the neighborhood. The street section shall include two through lanes plus parallel parking on both sides of the street for

single-family developments and on both sides of the street for multifamily developments. Public easements for utilities are required along both sides of the right-of-way.

7.3.3.4 Street Section

Figure 7-3. Local Typical Section: Single Family

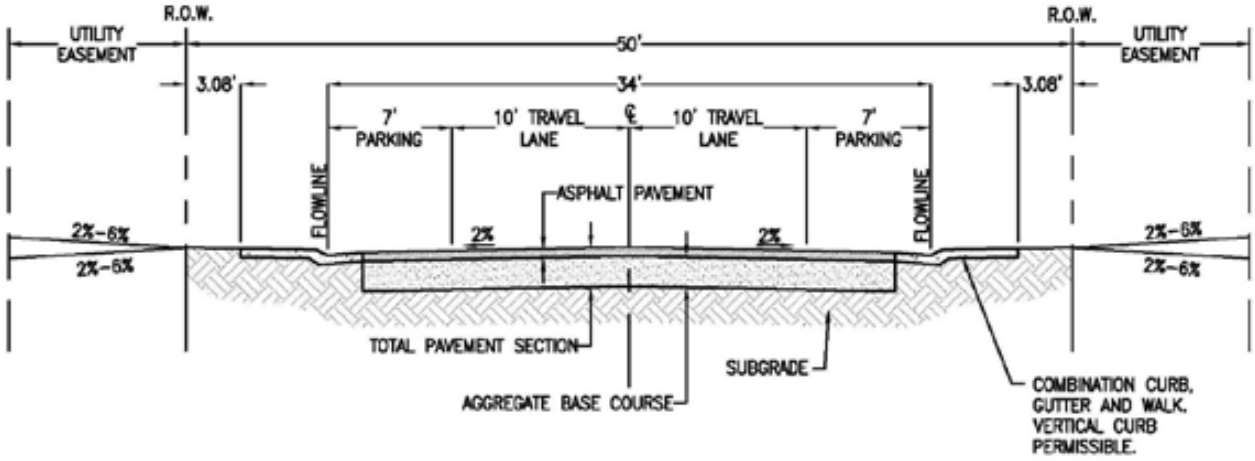
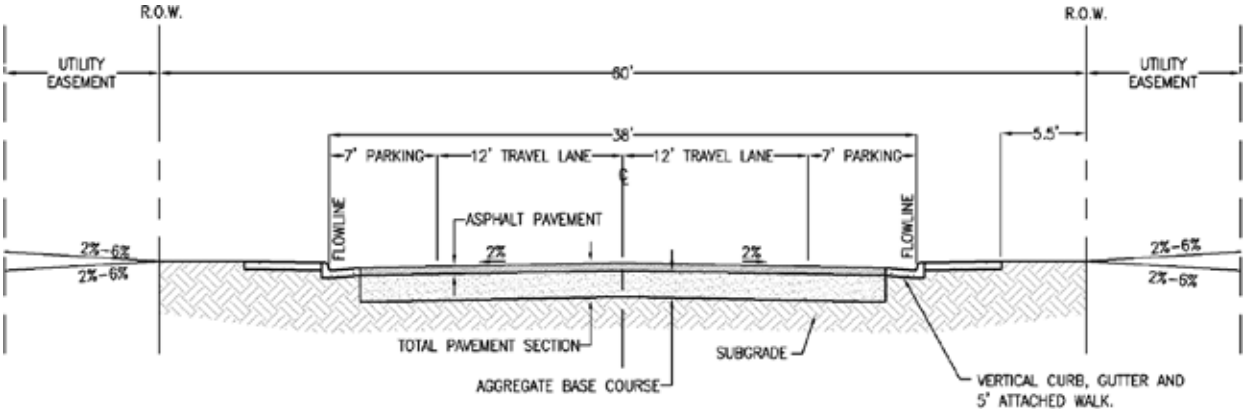


Figure 7-4. Local Typical Section: Multifamily



7.3.4 Entry Street

An Entry Street is generally short (160 feet minimum to the first intersection) with no driveway access and no parking. An Entry Street is intended to allow a reduction in the distance between a Localstreet and a Collector or Arterial street.

Posted Speed Limit	25 mph
Design Speed Limit	30 mph
Traffic Volumes	Maximum Design Volume is generally 1,500 vehicles per day. (Typically, capacity up to 3,000 vehicles per day is considered to be acceptable in fully established communities .)
Continuity	Limited

Right-of-Way	60-foot minimum 70-foot minimum for median
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	2
Type of Curb, Gutter, and Walk	6-inch vertical curb with 5-foot attached walk – both sides of street
Turnarounds	Not allowed
Knuckles	Not allowed
Eyebrows	Not allowed
Street Section	40 feet, flowline to flowline 56 feet, flowline to flowline for median
Street Grades	1% to 6%; 7% Mountainous
Minimum Centerline Curve Radii	225 feet
Curb Return Radii @ Arterial	35 feet
Curb Return Radii @ Collector	35 feet
Curb Return Radii @ Local	20 to 25 feet
K-Value Crest	19
K-Value Sag	37
Minimum VCL Crest	50 feet
Minimum VCL Sag	50 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.4.1 Function

Entry Streets provide no direct access to abutting property. Traffic carried by entry streets should have an origin or a destination within the neighborhood.

7.3.4.2 Access Conditions

Entry Streets shall only intersect with a Local street on one end, and a Major or Minor Collector or a Principal or Minor Arterial road on the other end. Direct access to abutting property is not permitted. Refer to Chapter 5 of these Roadway Standards.

7.3.4.3 Design Characteristics

This category of street is generally short (160 feet minimum to the first intersection) streets with no driveway access that are intended to allow a reduction in the separation between a Collector street and the first Local street intersection. If accepted by the City Public Works Department, up to 100 units may be allowed on an internally looped local road, using an entry street for primary access.

On-street parking is prohibited. "No Parking" signs shall be installed along both sides of the road in accordance with MUTCD and Chapter 9. An Entry Street is considered a lower classification street than a collector. Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4 these Roadway Standards.

7.3.4.4 School Access Street

The School Access Street functions as an Entry Street; however, a School Access Street shall include these additional criteria beyond the Entry Street criteria:

1) A School Access Street provides direct access to an elementary school.
2) The School Access Street may include varied speed limits and varied curb and gutter type.
3) The School Access Street will not be allowed on a dead end street.
4) The School Access Street may provide direct access to adjacent property.
5) This design shall not be used for access to high schools.
6) Traffic carried by School Access Streets may have an origin or a destination outside the local neighborhood.
7) Streets adjacent to play fields that do not provide direct access to the school would not be considered a School Access Street.
8) A School Access Street is considered a lower classification street than a Collector, but higher than a residential street.

7.3.4.5 Street Section

Figure 7-5. Entry Street Typical Section: No Median

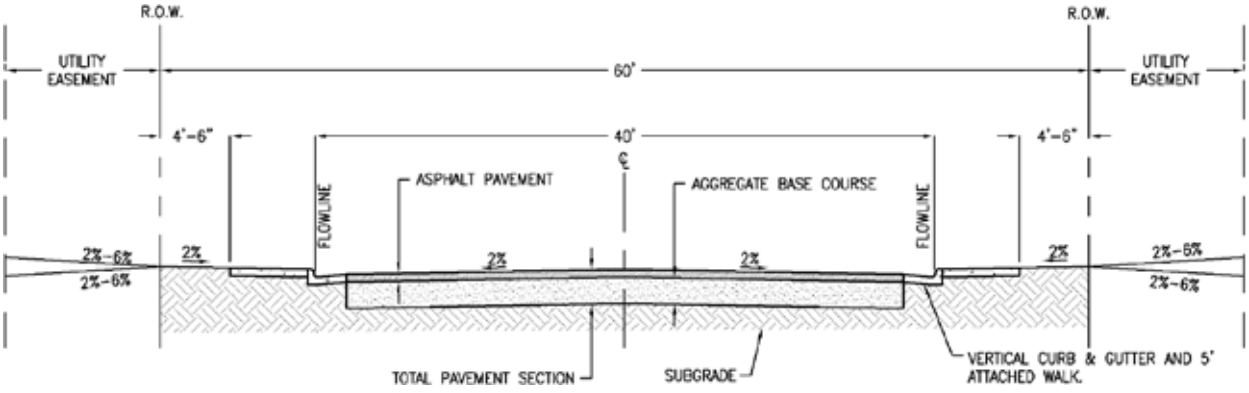


Figure 7-6. Entry Street Typical Section: With Median

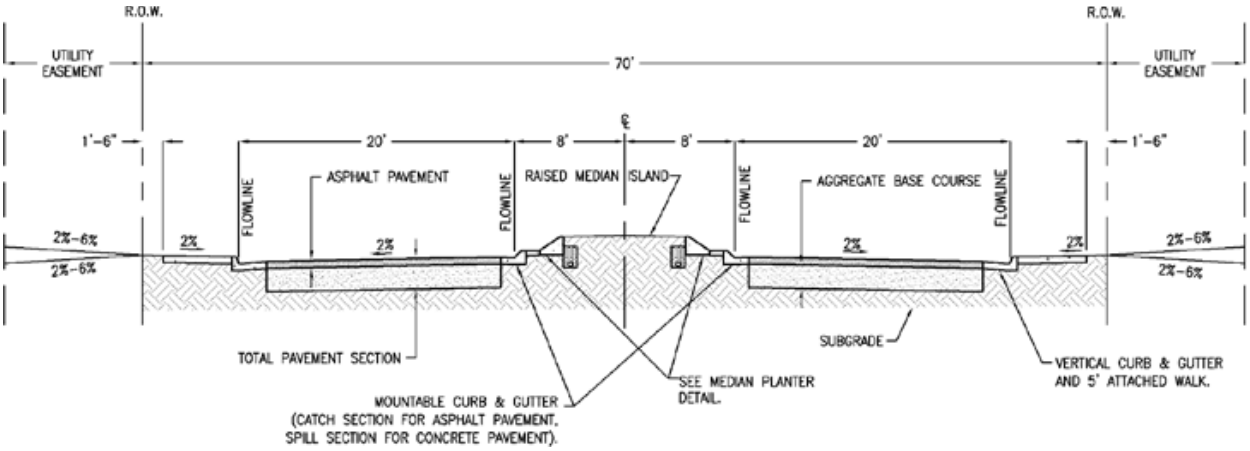
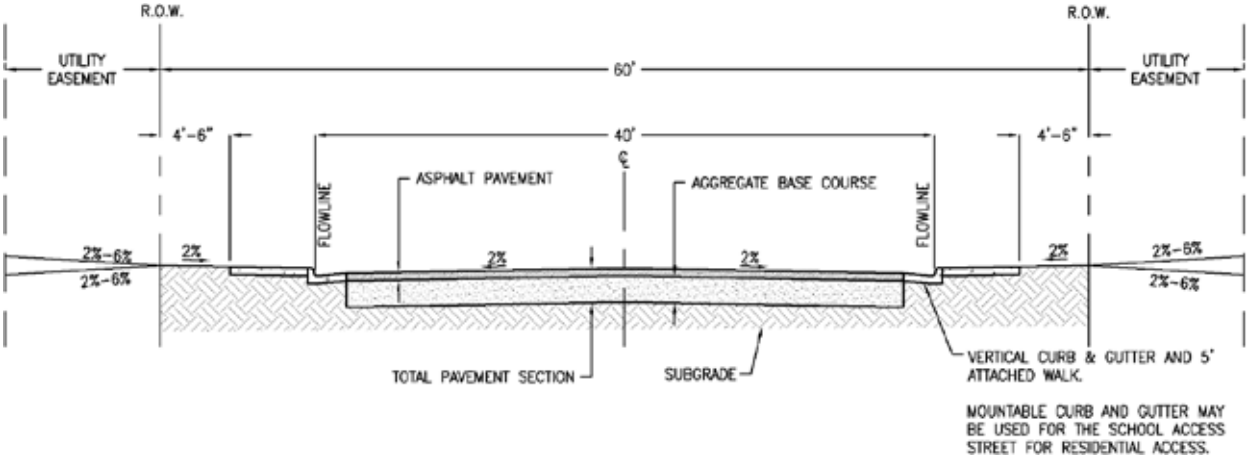


Figure 7-7. School Access Street Typical Section



7.3.5 Commercial and Industrial

Commercial and Industrial streets shall be designed for ease of access to adjacent commercial and industrial developments. On-street parking is not allowed. Backing or loading maneuvers are not allowed in the street.

Posted Speed Limit	25 mph
Design Speed Limit	30 mph
Traffic Volumes	Maximum Design Volume is generally 2,500 vehicles per day. (Typically, capacity up to 4,000 vehicles per day is considered to be acceptable in fully established communities)
Continuity	Limited
Right-of-Way	60-foot minimum
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	2

Type of Curb, Gutter and Walk	6-inch vertical curb with 5-foot attached walk – both sides of street
Turnarounds	The addition of a Turnaround on a Commercial or Industrial road type creates a Commercial and Industrial Cul-de-Sac. The maximum length of Commercial or Industrial Cul-de-Sacs shall be 600 feet. However, the City may impose additional restrictions on lengths based on factors, such as the types and products related to a proposed use, number of trips generated by the proposed use(s), number of employees or customers, types of vehicles used, available capacity, or access for emergency services. Commercial or Industrial Turnarounds shall have a flowline radius of 50 feet.
Knuckles	45-foot flowline radius on the inside and outside flowlines
Eyebrows	45-foot flowline radius, and a 25-foot curb return radius
Street Section	40-foot flowline to flowline
Street Grades	1% to 6%; 7% Mountainous
Minimum Centerline Curve Radii	225 feet
Curb Return Radii @ Arterial	N/A
Curb Return Radii @ Collector	35 feet
Curb Return Curb Radii @ Local	N/A
K-Value Crest	19
K-Value Sag	37
Minimum VCL Crest	50 feet
Minimum VCL Sag	50 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.5.1 Function

Commercial and Industrial streets provide direct access to abutting property. Traffic carried by Commercial and Industrial streets should have an origin or a destination within the commercial or industrial area.

7.3.5.2 Access Conditions

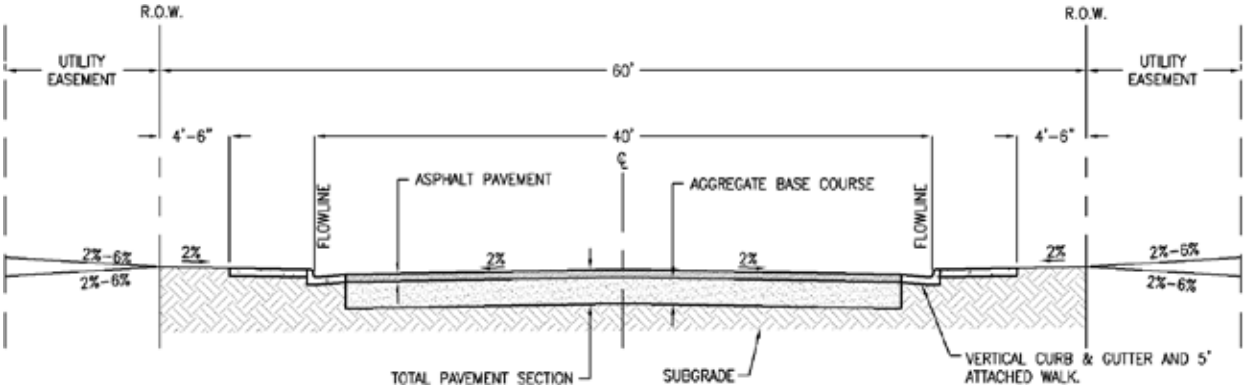
Commercial and Industrial streets shall only intersect with Local or Major and Minor Collector streets. Commercial and Industrial streets shall not intersect Principal or Minor Arterial streets. Direct access to abutting property is permitted. Refer to Chapter 5 of these Roadway Standards.

7.3.5.3 Design Characteristics

Commercial and Industrial streets shall be designed to carry traffic that has an origin or destination within the commercial or industrial area. This category of street shall be for ease of access to adjacent commercial and industrial developments. On-street parking is prohibited. "No Parking" signs shall be installed along both sides of the road in accordance with MUTCD and Chapter 9. Backing or loading maneuvers are not allowed in the street. Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4 of these Roadway Standards.

7.3.5.4 Street Section

Figure 7-8. Commercial and Industrial Typical Section



7.3.6 Collector

Minor and Major Collector streets collect and distribute traffic between Arterial and Local streets and serve as main connectors within communities, linking one neighborhood with another.

Posted Speed Limit	30 mph
Design Speed Limit	45 mph
Traffic Volumes	Maximum Design Volume is generally 7,000 vehicles per day. (Typically, capacity up to 10,000 vehicles per day is considered to be acceptable in fully established communities.)
Continuity	Less than 2 miles
Right-of-Way	60-foot minimum
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	2
Type of Curb, Gutter and Walk	6-inch vertical curb with 5-foot detached walk – both sides of street
Turnarounds	Not allowed
Knuckles	Not allowed
Eyebrows	Not allowed
Street Section	38 feet, flowline to flowline
Street Grades	2% to 6%; 7% Mountainous
Minimum Centerline Curve Radii	700 feet
Minimum Length of Tangents Between All Curves	50 feet
Curb Return Radii @ Arterial	50 feet
Curb Return Radii @ Collector	35 feet
Curb Return Radii @ Local	35 feet

K-Value Crest	29
K-Value Sag	49
Minimum VCL Crest	50 feet
Minimum VCL Sag	50 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.6.1 Function

Collector streets collect and distribute traffic between Arterial and Local streets and serve as main connectors within communities, linking one neighborhood with another. Traffic carried by Collector streets should have an origin or a destination within the community.

7.3.6.2 Access Conditions

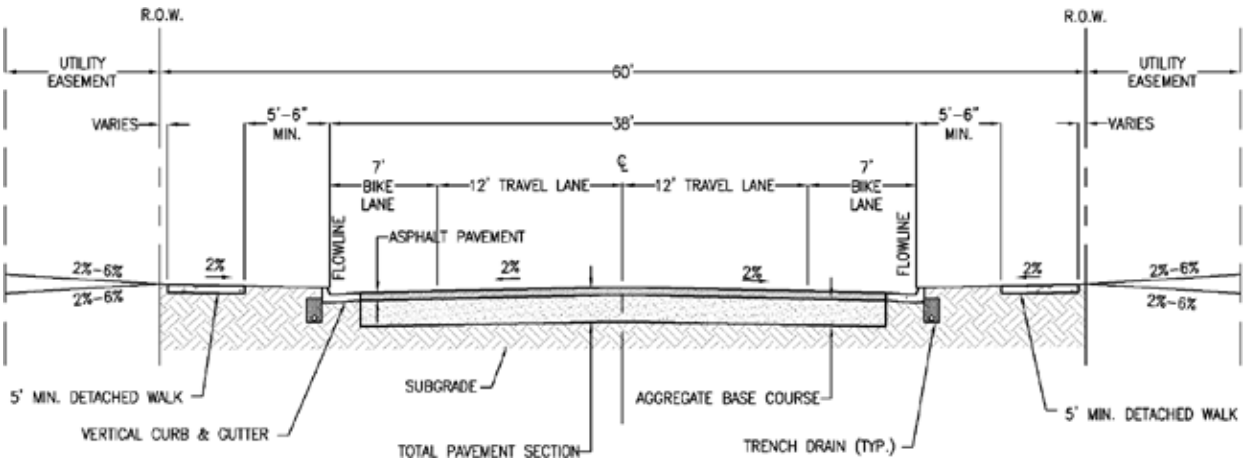
Major and Minor Collector streets shall only intersect with Local, Major or Minor Collector, and Principal or Minor Arterial streets. Single-family residential access is not permitted. Direct access to other zoned abutting property is not permitted unless another access is not reasonably available.

7.3.6.3 Design Characteristic

Collector streets should have continuity throughout a neighborhood but need not extend beyond the neighborhood. On-street parking is prohibited. Intersections and access points shall be spaced a minimum of 330 feet apart. Refer to Chapter 5 of these Roadway Standards. Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4, Utility Locations, of these Roadway Standards.

7.3.6.4 Street Section

Figure 7-9. Collector Typical Section



7.3.7 Minor Arterial

Minor Arterial routes allow rapid and relatively unimpeded traffic movement throughout the City. Arterial roadways are designed to handle traffic volumes from and onto Collector and Arterial roads and State Highways. A Minor Arterial has a minimum distance of a quarter-mile between intersections.

Posted Speed Limit	Greater than or equal to 40 mph – Determined by the City Public Works Department prior to Construction Plan Submittal
Design Speed Limit	55 mph
Traffic Volumes	Maximum Design Volume – 15,000 vehicles per day
Continuity	Two or more miles – generally connecting intercity routes
Right-of-Way	125-foot minimum
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	4
Type of Curb, Gutter and Walk	6-inch vertical curb with 10-foot detached walk – both sides of street
Turnarounds	Not allowed
Knuckles	Not allowed
Eyebrows	Not allowed
Street Section	70 feet, flowline to flowline
Street Grades	2% to 6%
Minimum Centerline Curve Radii	1,200 feet
Minimum Length of Tangents Between All Curves	100 feet
Curb Return Radii @ Arterial	50 feet
Curb Return Radii @Collector	50 feet
Curb Return Radii @ Local	N/A
K-Value Crest	84
K-Value Sag	96
Minimum VCL Crest	70 feet
Minimum VCL Sag	60 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.7.1 Function

Minor Arterial routes allow relatively unimpeded traffic movement and are intended for use on routes where four moving lanes and one left-turn lane are required but where a Major Arterial cross-section would not be warranted.

7.3.7.2 Access Conditions

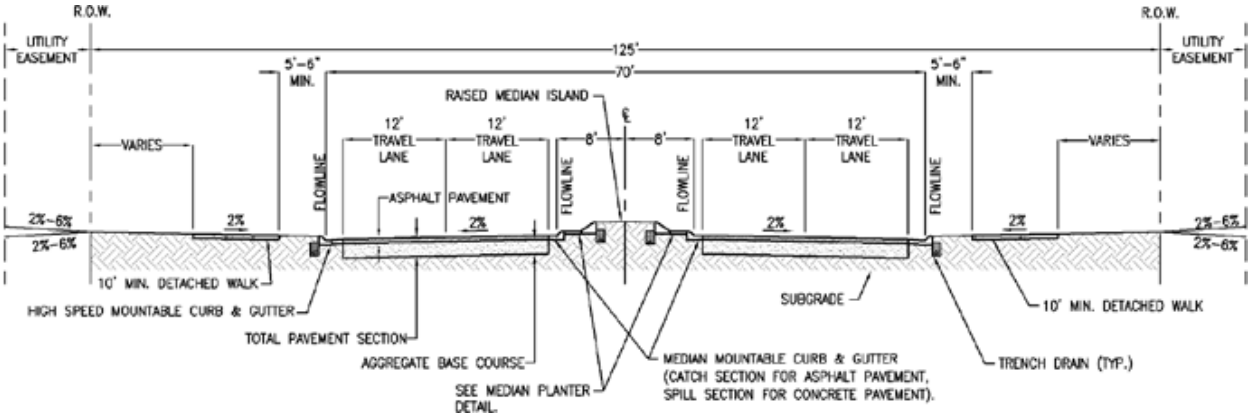
Access from Major or Minor Collector and Minor or Principal Arterial streets will be allowed. Residential access is not permitted. Direct access to other abutting property is not permitted unless no other access is reasonably available.

7.3.7.3 Design Characteristics

Minor Arterials should be spaced from a half a mile to 1 mile apart and should be continuous. On-street parking is prohibited. Intersections and access points should be spaced a minimum of a quarter-mile apart. Refer to Chapter 5 of these Roadway Standards. Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4 of these Roadway Standards.

7.3.7.4 Street Sections

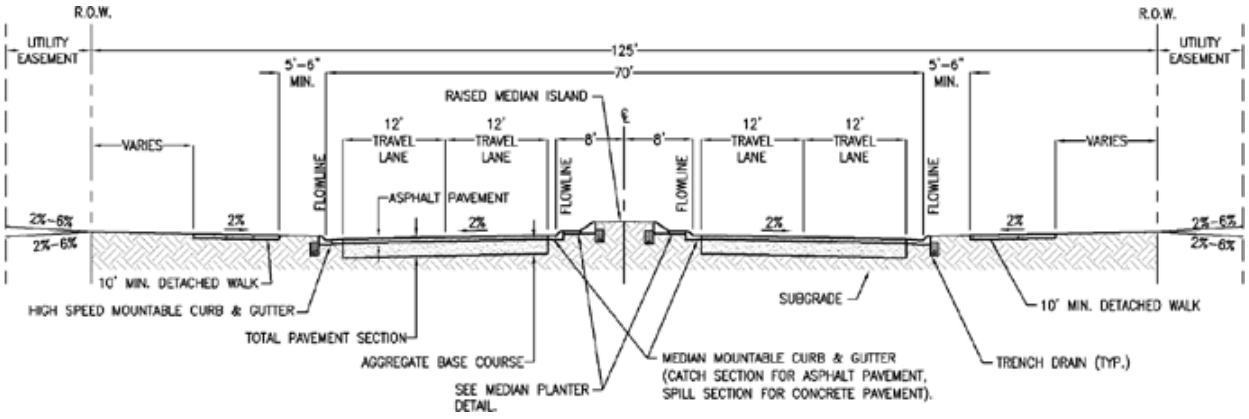
Figure 7-10. Minor Arterial Typical Section



7.3.7.5 Typical Minor Arterial Road Section

- Minimum of four 12-foot through lanes and two 2-foot gutter pans
- Minimum 16-foot median, measured curb face to curb face, with two barrier curbs and gutter (Note: If asphalt pavement is used, a 1-foot catch curb and gutter is required. A median planter may be constructed in this median.)
- Two detached sidewalks, minimum 10 feet each. Minimum 5.5-foot setback from curb face
- Minimum 125-foot right-of-way
- Variable size of utility easement adjacent to each right-of-way line

Figure 7-11. Minor Arterial Typical Section



7.3.7.6 Typical Arterial Road Section at Intersection

- Minimum of four 12-foot through lanes and two 2-foot gutter pans
- Minimum 12-foot left turn lane
- Minimum one 12-foot acceleration and one 12-foot deceleration lane
- Minimum 1-foot painted median
- Two detached sidewalks, minimum 10 feet each; 5.5-foot minimum setback from curb face
- Minimum 130-foot right-of-way
- Variable size of utility easement adjacent to each right-of-way line

7.3.8 Principal Arterial

Principal Arterials should be spaced approximately 1 mile apart and should traverse an entire city. Major Arterial streets should not bisect neighborhoods but should act as boundaries between them. Arterial routes allow rapid and relatively unimpeded traffic movement throughout the City. Arterial roadways are designed to handle traffics volumes from and onto Collectors, Arterial roads, and State Highways. Principal Arterials have a minimum distance of a quarter-mile between intersections.

Posted Speed Limit	Greater than or equal to 40 mph – Determined by the City Public Works Department prior to Construction Plan Submittal
Design Speed Limit	60 mph
Traffic Volumes	Design Volume is generally over 15,000 vehicles per day for a Principal Arterial. (Phasing of lane requirements may be considered based on Traffic Impact Analysis.)
Continuity	Several miles, generally connecting inter and intra city routes
Right-of-Way	140-feet, four-lane minimum
Traffic Control	Signage and pavement markings in accordance with MUTCD and Chapter 9 of these Roadway Standards
Number of Travel Lanes	4
Type of Curb, Gutter and Walk	6-inch barrier curb and gutter with 10-foot detached sidewalk on both sides
Turnarounds	Not allowed
Knuckles	Not allowed

Eyebrows	Not allowed
Street Section	82 feet, flowline to flowline
Street Grades	2% to 6%
Minimum Centerline Curve Radii	1,500 feet
Minimum Length of Tangents Between All Curves	100 feet
Curb Return Radii @ Arterial	50 feet
Curb Return Radii @ Collector	50 feet
Curb Return Radii @ Local	N/A
K-Value Crest	84
K-Value Sag	96
Minimum VCL Crest	110 feet
Minimum VCL Sag	90 feet
Maximum Int. Gradient	Refer to Figure 7-21

7.3.8.1 Function

Principal Arterial routes allow rapid and relatively unimpeded traffic movement throughout the City, connecting major land uses.

7.3.8.2 Access Conditions

Access from Collector and Arterial streets will be allowed. Direct access to abutting property is not permitted.

7.3.8.3 Design Characteristics

Principal Arterials should be spaced approximately 1 mile apart and should traverse an entire city. On-street parking is prohibited. Intersections and access points should be spaced a minimum of a quarter-mile apart. Refer to Chapter 5, Access Requirements and Criteria, and these Roadway Standards. Public easements for utilities are required along both sides of the right-of-way. Refer also to Chapter 4, Utility Locations Design and Construction Standards, of these Roadway Standards.

7.3.8.4 Street Section

Figure 7-12. Principal Arterial: Four-Lane Road Section

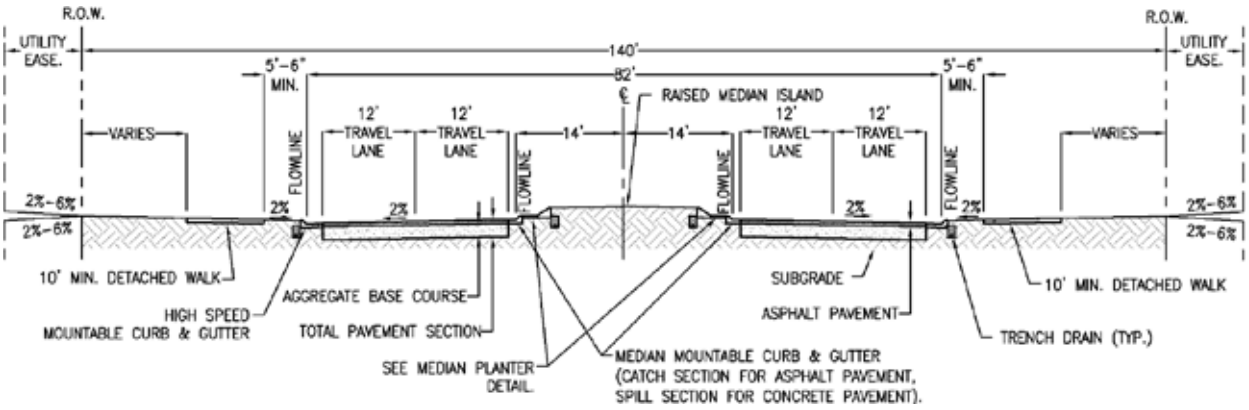
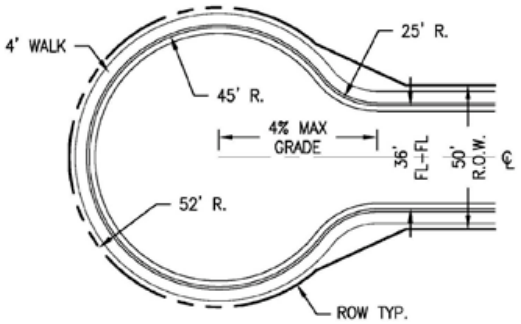
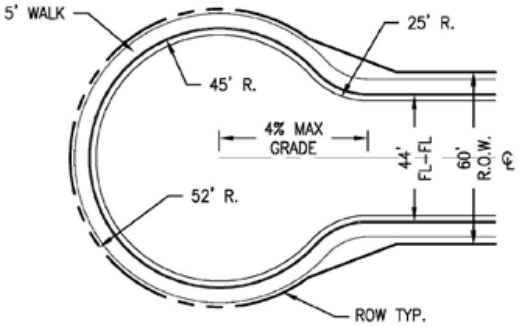


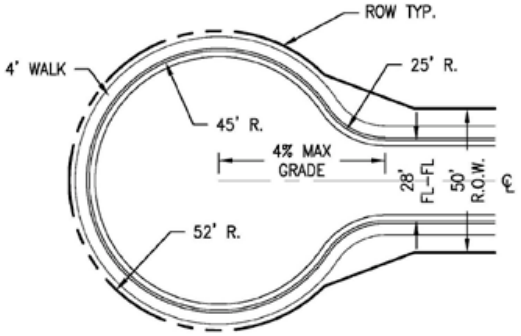
Figure 7-13. Turnarounds



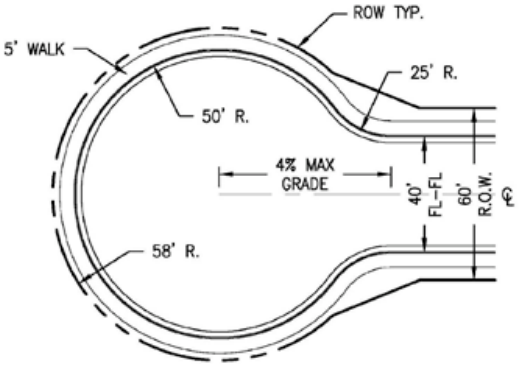
Cul-de-Sac (Single Family)



Cul-de-Sac (Multifamily)

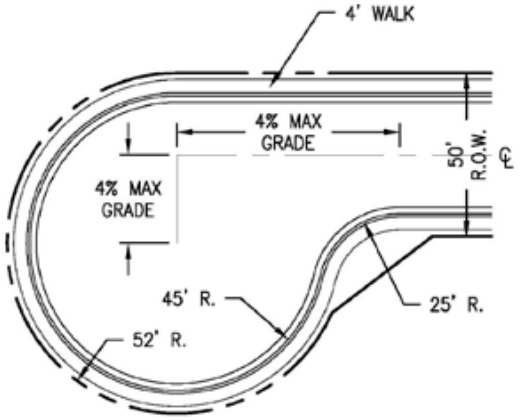


Local

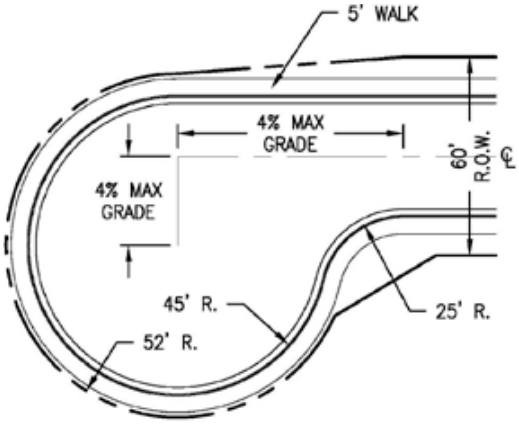


Commercial and Industrial

Figure 7-14. Offset Turnarounds

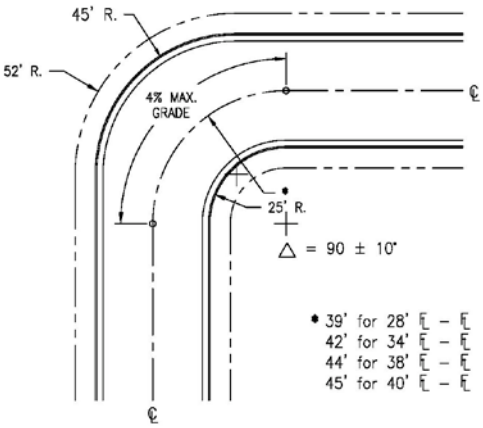


50-foot Right-of-Way

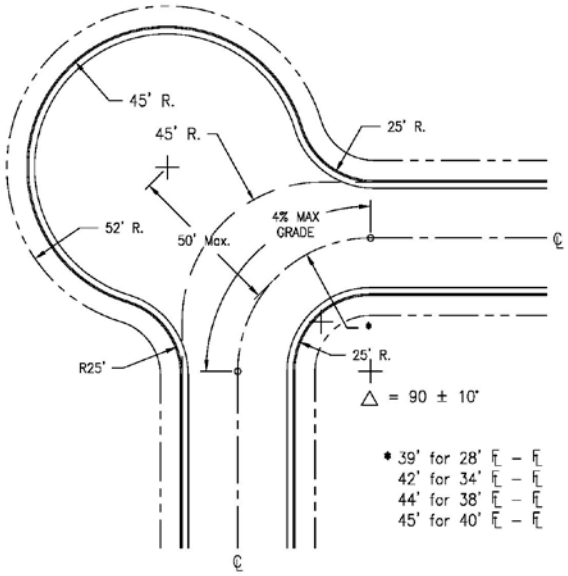


60-foot Right-of-Way

Figure 7-15. Knuckles

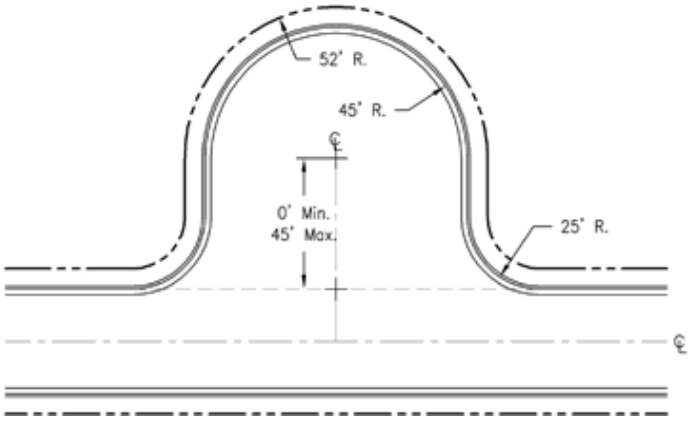


Without Bubble



With Bubble

Figure 7-16. Eyebrows



7.4 Sidewalks, Trails, and Curb Ramps

All sidewalks that run parallel with the public street shall be located within the City right-of-way. If a sidewalk meanders outside of the City right-of-way, it must be located in a Sidewalk Easement for public use. Concentrated storm water runoff must not be discharged across the sidewalk. (See Section 7.6.3)

State law (CRS 43-2-107[2]) requires that curb ramps be installed at all intersections and at mid-block crossing locations for all new construction or reconstruction of curbs and sidewalks. Curb ramps shall be constructed in accordance with City of Castle Pines Standard Details found in Appendix A of these Roadway Standards. Curb ramps shall be shown at all curb returns and at all "T" intersections where sidewalks are required or proposed. Whenever referencing a curb ramp, call out the specific City of Castle Pines Standard Detail to be used to construct that ramp. Special consideration for ramp design may be necessary because of site-specific issues, such as cross slope or drainage, with acceptance by the City.

At least one *Americans with Disabilities Act* (ADA) accessible route shall be provided within a site from accessible parking spaces and accessible passenger loading zones, public streets and sidewalks, and public transportation stops to the accessible building or facility entrance they serve. All curb ramp designs must be in compliance with the latest ADA design guidance. ADA compliance supersedes the Standard Details.

Grade-separated pedestrian crossings at Collector and Arterial roads shall be constructed whenever possible for regional or neighborhood trails, golf cart crossings, and equestrian crossings.

Contact the City to determine whether there are planned designated City of Castle Pines Bicycle Facilities or existing or planned designated school routes that need to be considered in the design.

7.5 Cuts and Driveways

Curb cuts and driveways shall be constructed in accordance with City of Castle Pines Standard Details found in Appendix A of these Roadway Standards. See Chapter 5 for additional curb cut and driveway criteria.

7.6 Drainage

The minor and major storm drainage systems are to be designed in accordance with City Standards. In the case of a conflict caused by requirements of other criteria manuals, the most restrictive shall govern.

7.6.1 Crosspans

Crosspans are not allowed to cross the major street at an intersection. In the event the roadways have the same classification, then the road with the higher assumed volume is considered the major street. No mid-block crosspans will be allowed.

Crosspans shall be constructed in accordance with the City of Castle Pines Standard Details. Crosspans are not permitted across Arterial roadways.

Local road intersections require a minimum 8-foot-wide crosspan.

Minor Collector road intersections require a minimum 10-foot-wide crosspan.

Arterial road intersections do not allow a crosspan.

7.6.2 Inlets

Inlets shall be constructed in accordance with the City of Castle Pines Standard Details. Type R inlets are required along roadways owned and maintained by the City. Type R inlets shall be 5, 10, or 15 feet in length. Type R inlets 20 feet in length may be allowed on a case-by-case basis. Inlets exceeding 20 feet in length are not acceptable.

Inlets shall be located to intercept the curb flow at the point the allowable curb flow capacity is exceeded by the storm runoff. Inlets shall also be installed to intercept cross-pavement flows at points of transition in super-elevations.

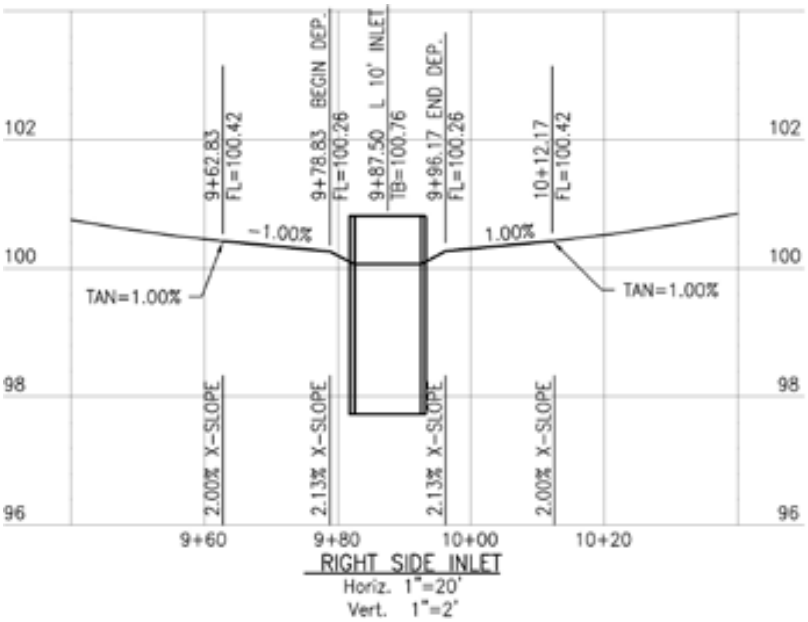
For all streets with raised medians constructed with asphalt, the median shall be constructed with a "catch" curb and gutter, with inlets required along the median to reduce ponding at curb and gutter low points and to eliminate concentrated flow crossing over the lanes of traffic at the nose of the median. The final design and construction drawings must address inlet sizing, dimensions, and required curb and gutter transitions. Refer to the Standard Details, which present a conceptual representation of options available for placing median nose inlets.

Because of the presence of curb ramps, inlets are not allowed in the curb return, but will be located at the tangent points of the curb returns.

Refer to the City's Storm Drainage Design Criteria and City of Castle Pines Standard Details located in Appendix A of these Roadway Standards for inlet types allowed.

The City requires a minimum 1% flowline grade into all sump inlets. See Figure 7-17.

Figure 7-17. Sump Inlet Profile



An 8-inch opening should be included on the upgrade side of an on-grade inlet and on each end of a sump inlet to accommodate trench drain installation. See City of Castle Pines Standard Details for criteria.

7.6.3 Sidewalk Chases

Sidewalk chases will only be permitted as a final alternative through the variance process. Typically, sidewalk chases are allowed only for retrofit projects as accepted by the City. When permitted, sidewalk chases are to be used to allow surface drainage to enter into the street gutter, and not to avoid the use of a standard inlet.

There are numerous reasons why sidewalk chase sections should be limited in use and allowed only in retrofit situations. These reasons include the following:

- Cost of future maintenance
- Excessive ice buildup in the gutter or street
- Algae growth within the gutter
- Pedestrian tripping hazard

Experience has also shown that in many instances where a sidewalk chase is warranted, the need for the sidewalk chase dissipates and eventually disappears over time.

Storm water from concentrated points of discharge (that is, sump pumps and roof drains) shall not be allowed to flow over sidewalks. Sidewalk chase sections will not be allowed where homeowners have routed their sump pump discharge pipe or roof drains directly to the back of the sidewalk. Sidewalk chase sections should only be used where it is not feasible to use other forms of mitigation.

In the event a sidewalk chase is accepted, the chase sections shall not be located within the curb cut or driveway. Accepted sidewalk chase sections are to be constructed in accordance with the City of Castle Pines Standard Details found in Appendix A of these Roadway Standards. The Applicant shall be responsible for replacing the property corner offset in its original location in conformance with state statutes.

7.6.4 Trench Drains

Trench drains are required along both sides of all public Collectors and Arterials with curb and gutter. Trench drains are not required if the street has shoulders and roadside ditches. All proposed irrigated landscaping adjacent to a public street must have a positive draining trench drain located behind the curb, or behind the sidewalk if attached.

The trench drain must flow into either a storm inlet or a natural drainageway.

- If the trench drain ties into the storm sewer, the inlet must be indicated on the plan, and a detail of the storm sewer tie in must be included.
- If the trench drain discharges into a natural drainageway, the name of the drainageway must be called out on the plan, and the trench drain discharge point indicated on the plan. A detail of the outlet with permanent erosion protection must also be included on the plan. A concrete collar (3 inches minimum around pipe and 6 inches thick) with a minimum 2-foot-by-6-foot pad of type L riprap placed over filter fabric is required. A drainage easement is required for a trench drain outside of the public right-of-way. The plan also needs to call for a marker post to identify the trench drain discharge point.

If a proposed trench drain is not following the road grade, a profile of the trench drain is required on the plan, including the surface ground elevation and the tie into the storm sewer or discharge point to a natural drainageway.

An exception to the trench drain requirements may be considered for the following conditions:

- If soils in the area are non-expansive, the Applicant may submit a Variance Request (signed and stamped by a Colorado-registered Geotechnical Professional Engineer [PE]), which states that there will not be a problem with water migrating under the roadway from the irrigated landscaping proposed adjacent to this public street. If this Variance Request is accepted by the City Public Works Department, a trench drain will not be required.
- If the ground behind the curb or attached sidewalk falls away from the public street at a minimum of 6% for a total of 25 feet from the back of curb or walk, a trench drain may not be required.

7.6.5 Rural Roadside Ditches

The City does not use rural road section or rural roadside ditches.

7.6.6 Temporary Erosion and Sediment Control

Temporary erosion control is required along and at the ends of all roadways that are not completed for reasons, such as project phasing or subdivision boundaries, in accordance with the City of Castle Pines Grading, Erosion and Sediment Control Manual.

7.7 Horizontal Alignment

7.7.1 General

The major considerations in alignment design are safety, grade, profile, road section, design speed, sight distance, topography, drainage, and vehicular operation. Alignment should provide for safe and continuous operation at a uniform design speed. Road layout shall bear a logical relationship to existing or platted roads in adjacent properties.

7.7.2 Horizontal Curves

Refer to Table 7-1.

7.7.3 Intersection Curb Return Radii

Refer to Table 7-1.

7.7.4 Design Speed

Horizontal alignment design speed shall be consistent with the requirement for vertical alignment design speed.

Speed limits posted on new roads are typically 5 mph under the design speed. Posted speed limits may be adjusted by the City to reflect actual roadway conditions and circumstances.

7.7.5 Superelevation

Superelevation shall not be used on any roadway classifications with a design speed of 50 mph or less.

Superelevation shall not be used without prior acceptance by the City Public Works Department. If a superelevated design is applied for, American Association of State Highway and Transportation Officials (AASHTO) design standards shall be used.

7.7.6 Railroad Crossings

Railroad crossings are not permitted unless the City and the affected railroad company accept them.

7.8 Vertical Alignment

7.8.1 Permissible Roadway Grades (refer also to Sight Distance on Vertical Curves)

A minimum longitudinal flowline grade of 1.0% shall be required on all Local streets.

A minimum longitudinal grade of 2.0% shall be required along the centerline of all Collector and Arterial streets.

The maximum allowable grade for any roadway is shown on Table 7-1 of these Roadway Standards.

The minimum flowline grade around Knuckles or Eyebrows shall be 2.0%, which may require the street grade to be steeper than 1.0%.

The maximum centerline grade within a Turnaround is 4.0%. The maximum centerline grade within a Knuckle is 4.0%.

Figure 7-18. Flowline Grade around Curves

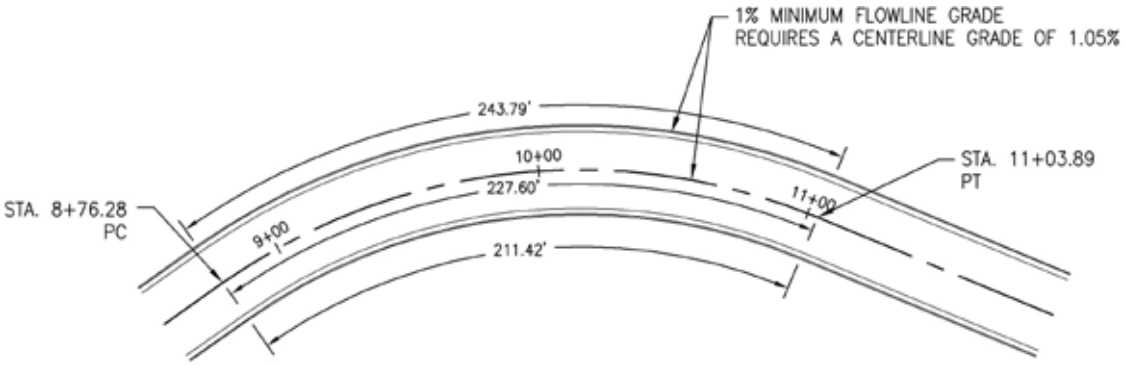
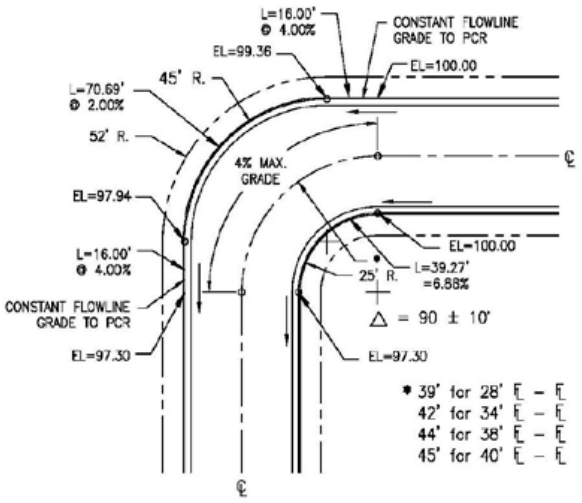
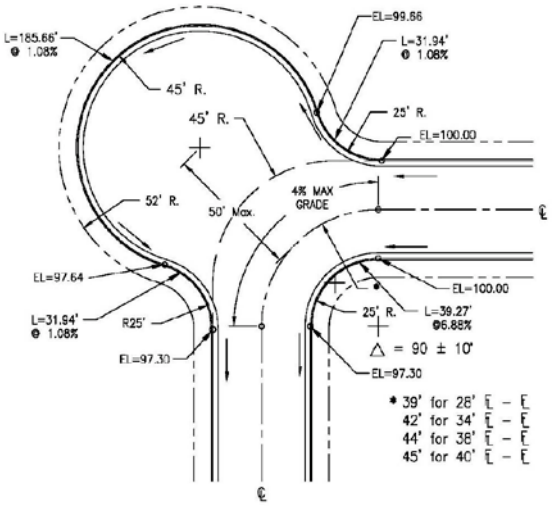


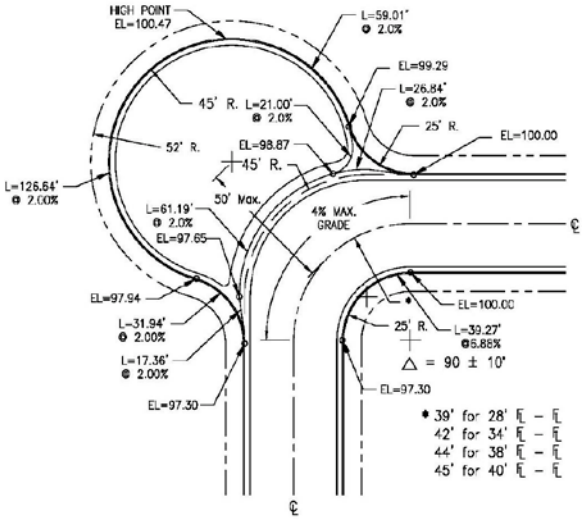
Figure 7-19. Flowline Design around Knuckles



No Bubble

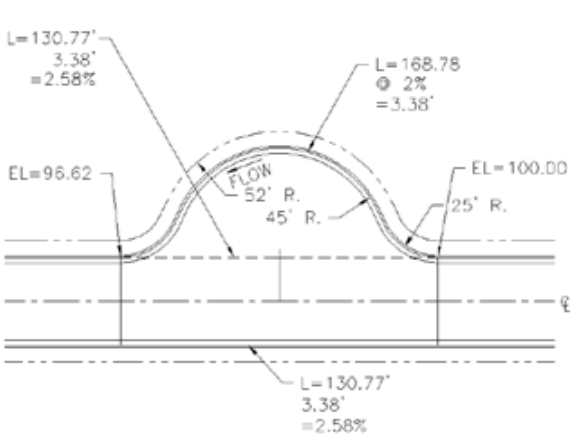


With Bubble, Gradethrough Entire Knuckle

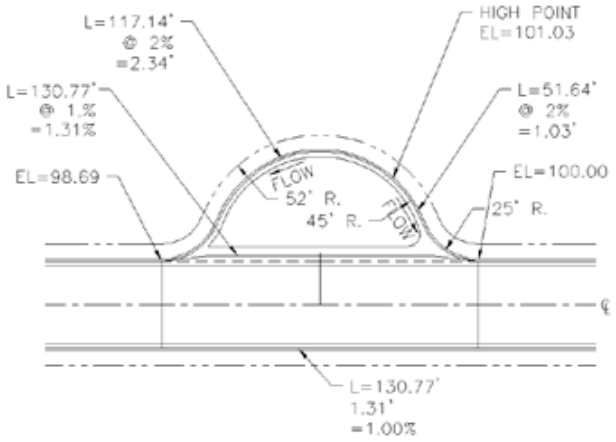


With Bubble, High Point in Bubble,2% Grade inBoth Directions

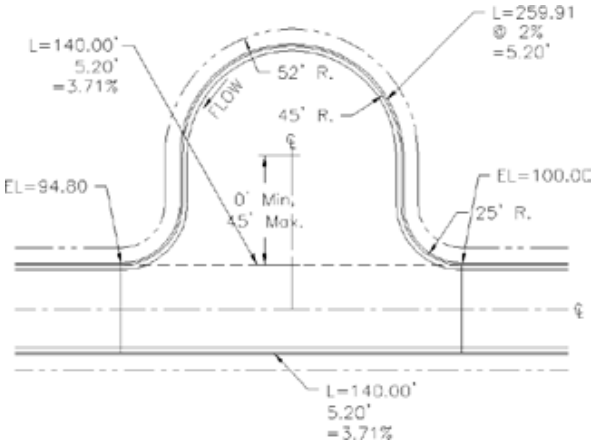
Figure 7-20. Flowline Design around Eyebrows



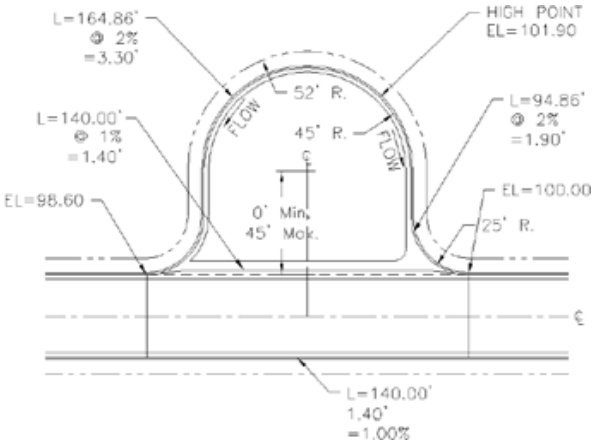
0-foot Offset, 2% Gradethrough Entire Eyebrow



0-foot Offset, High Point with 2% Grade inBoth Directions



45-foot Offset, 2% Gradethrough Entire Eyebrow



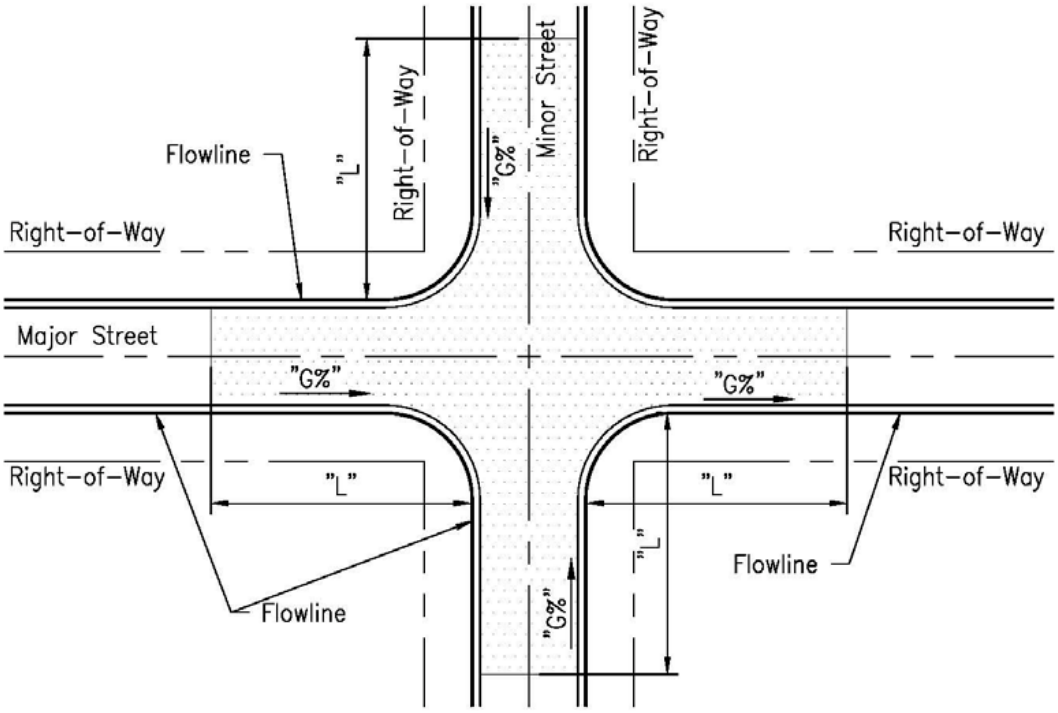
45-foot Offset, High Point with 2% Grade inBoth Directions

7.8.2 Permissible Intersection Grades

The minimum length of the maximum permissible intersection grade is measured from the flowline of the through street to a point along the centerline of the intersecting street where the grade of the intersecting street does not exceed the grade shown on Figure 7-21 and Table 7-2.

The cross slope of the through street shall be maintained through intersections.

Figure 7-21. Permissible Intersection Grade Layout



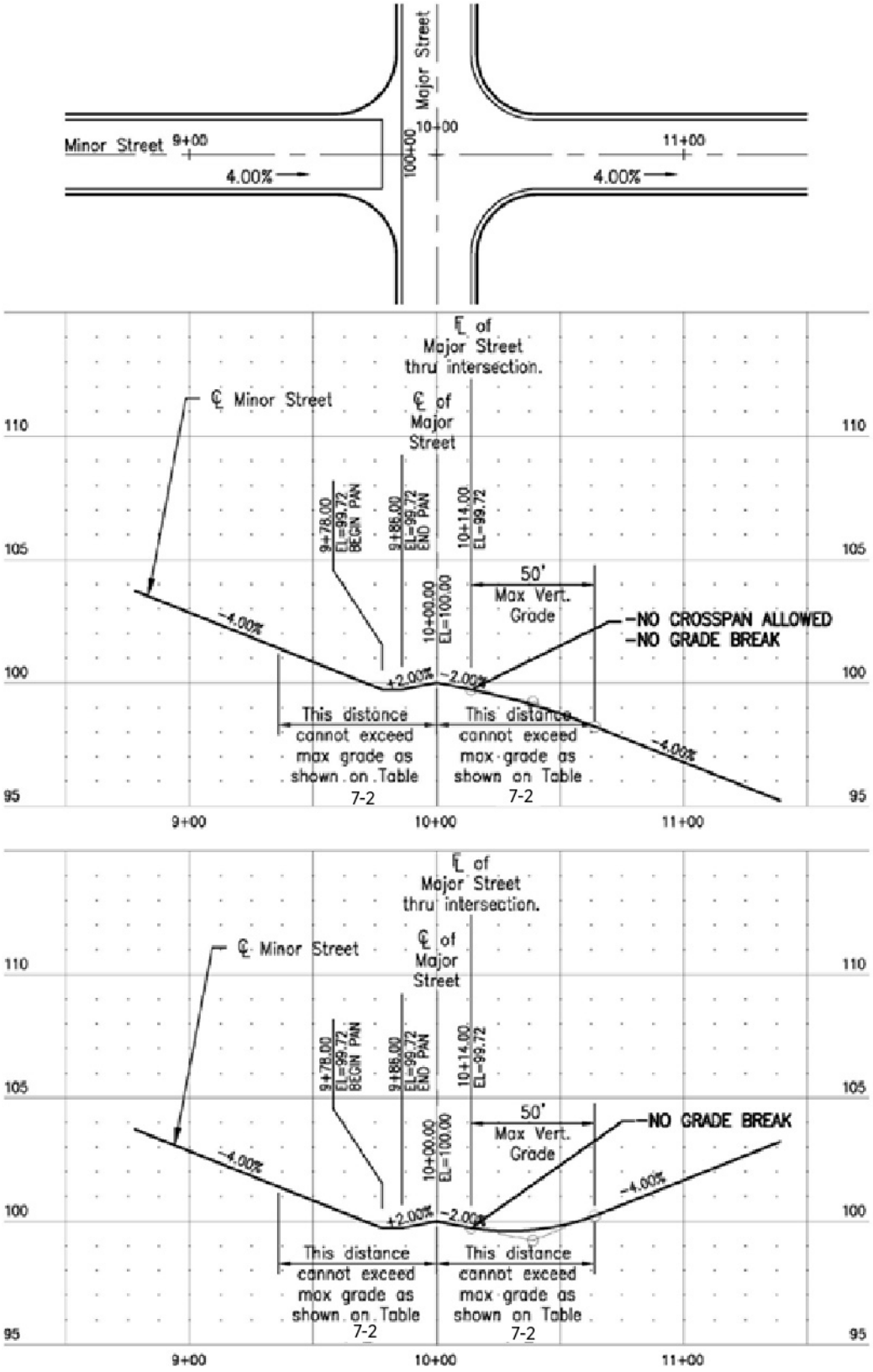
L = Minimum Length Required G = Maximum Grade Allowed See Table 7-2 for information.

The longitudinal slope of the Major Street shall continue through the intersection and may be greater than the max “G” shown in Table 7-2 except at Major Collectors and Arterials.

Table 7-2. Permissible Intersection Grades

Major Street / Minor Street	Cul-De- Sac	Local	Entry Street	School Access Street	Commercial & Industrial	Collector	Minor Arterial	Principal Arterial
Cul-De-Sac	L=95' G=4%	L=95' G=4%	L=95' G=4%	L=95' G=4%	L=95' G=4%	N/A	N/A	N/A
Local	N/A	L=95' G=4%	L=95' G=4%	L=95' G=4%	L=95' G=4%	N/A	N/A	N/A
Entry Street	N/A	N/A	L=95' G=4%	L=95' G=4%	N/A	L=100' G=4%	L=150' G=3%	L=150' G=3%
School Access Street	N/A	N/A	L=95' G=4%	L=95' G=4%	N/A	L=100' G=4%	L=150' G=3%	L=150' G=3%
Commercial & Industrial	N/A	L=95' G=4%	L=95' G=4%	L=95' G=4%	L=95' G=4%	L=100' G=4%	L=150' G=3%	L=150' G=3%
Collector	N/A	N/A	N/A	N/A	N/A	L=100' G=4%	L=150' G=3%	L=150' G=3%
Minor Arterial	N/A	N/A	N/A	N/A	N/A	N/A	L=200' G=2%	L=200' G=2%
Principal Arterial	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L=200' G=2%

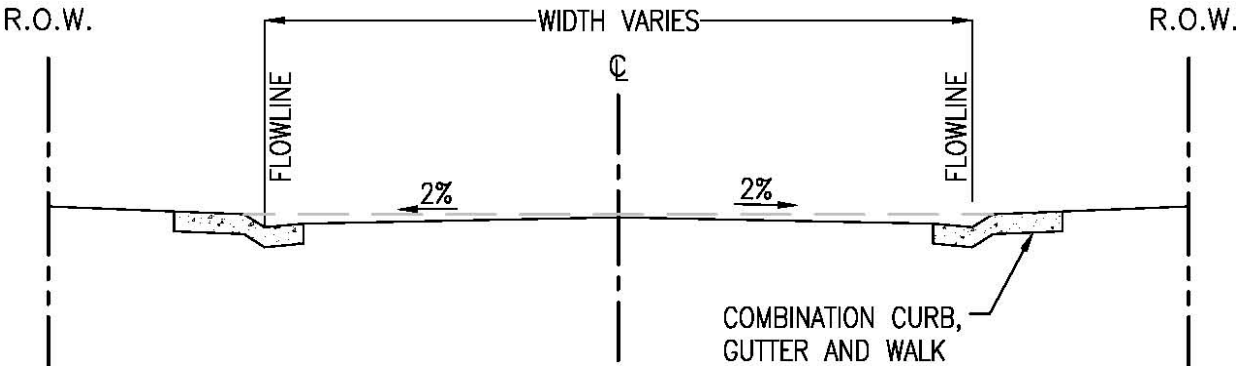
Figure 7-22. Permissible Intersection Grade Example



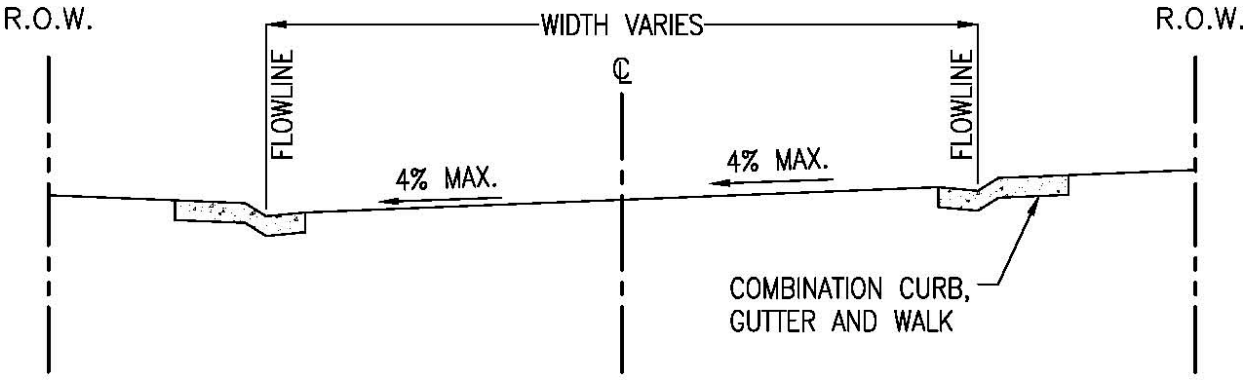
7.8.3 Cross Slope

Typically, roadways shall have a crown in the center with a minimum 2% cross slope with curbs at the same elevation at the same station. The maximum permissible cross slope is 4%. The pavement cross slope at intersections shall not exceed the grade of the through street. Parabolic or curved crowns are not allowed.

Figure 7-23. Cross Slope Example



Typical Roadway Cross Slope



Maximum Roadway Cross Slope

The rate of change for roadway cross slope, when warping side streets at intersections, shall not exceed the following criteria:

- Local Streets: 1% every 25 feet horizontally along the roadway
- Collector Streets: 1% every 37.5 feet horizontally along the roadway
- Arterial Streets: 1% every 56.5 feet horizontally along the roadway

7.8.4 Grade Breaks and Vertical Curves

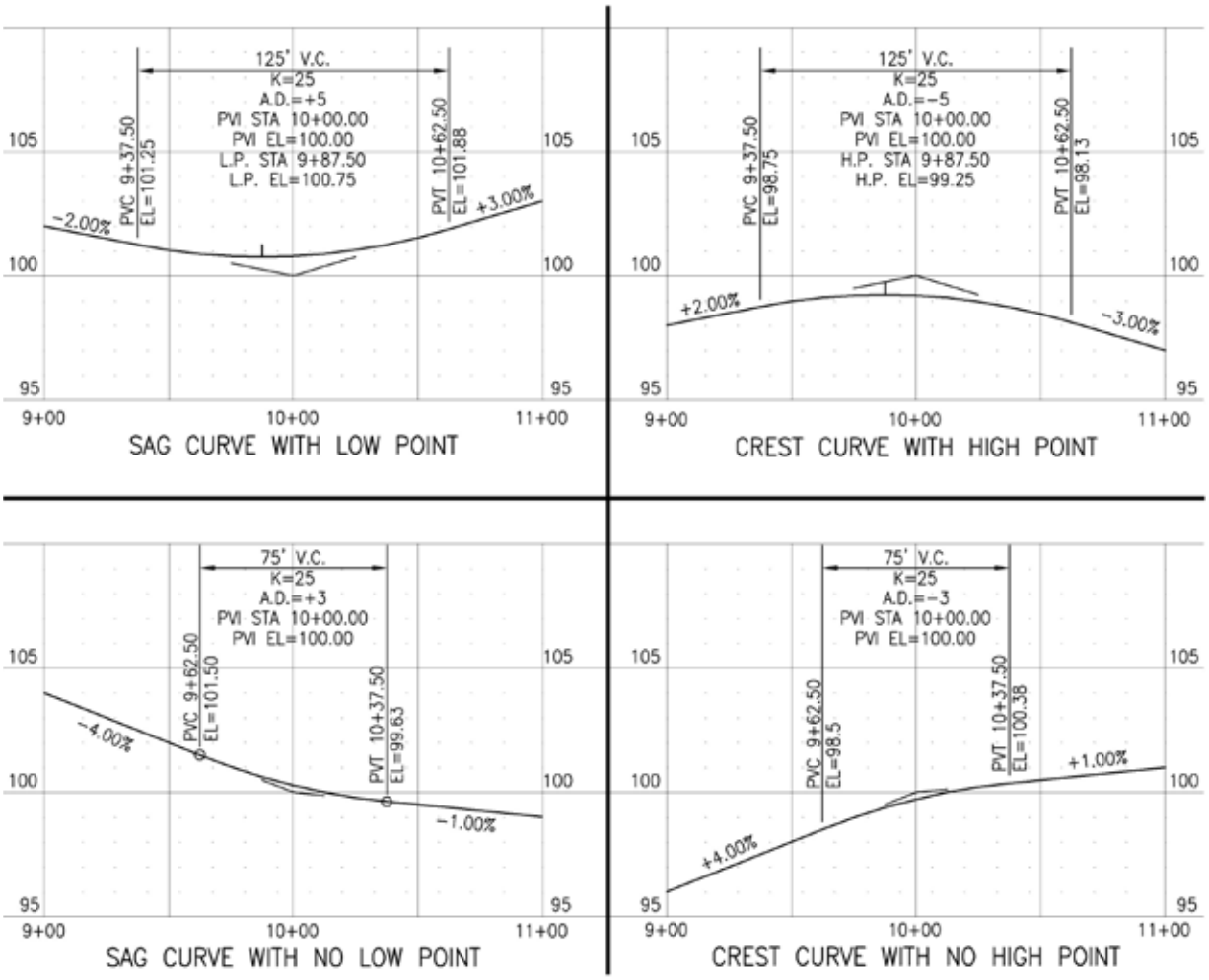
The use of grade breaks in lieu of vertical curves is discouraged. However, if a grade break is necessary, and the algebraic difference in grade does not exceed 0.5% along the roadway flowline, the grade break may be permitted.

When the algebraic difference in grade (A) is at or exceeds 0.5%, a vertical curve shall be used. Design criteria for vertical curves are found in Table 7-1 of these Roadway Standards. Minimum length of a vertical curve is also shown in Table 7-1. All vertical curves shall be labeled, in the profile, with length of curve (L) and K = (L/ A) values.

The maximum grade break allowed at the PT at a curb return for local and collector roads shall be 2%; for arterial roadways, it shall be a maximum of 1%.

All flowline vertical curves in Knuckles and Bubbles shall have a maximum length of 50 feet.

Figure 7-24. Vertical Curve Examples



7.9 Intersections

The grade of the through street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the City, shall have precedence. The design should warp side streets to match through streets with as short a transition as possible. Refer to Section 7.8.3 for the rate of change in pavement cross slope when warping side streets at intersections.

The key criteria for determining the elevation of the curb return on the side street and the amount of warp needed on a side street transitioning to a through street are as follows:

- Pavement cross slope at the point of curb return (PCRs) on the side street and permissible warp in pavement cross slope (refer to Section 7.8.3).
- The maximum permissible cross slope is 4% between the PCRs.
- Normal vertical curve criteria (refer to Section 7.8.4).
- Vertical controls within the curb return itself (refer to Section 7.9.1).

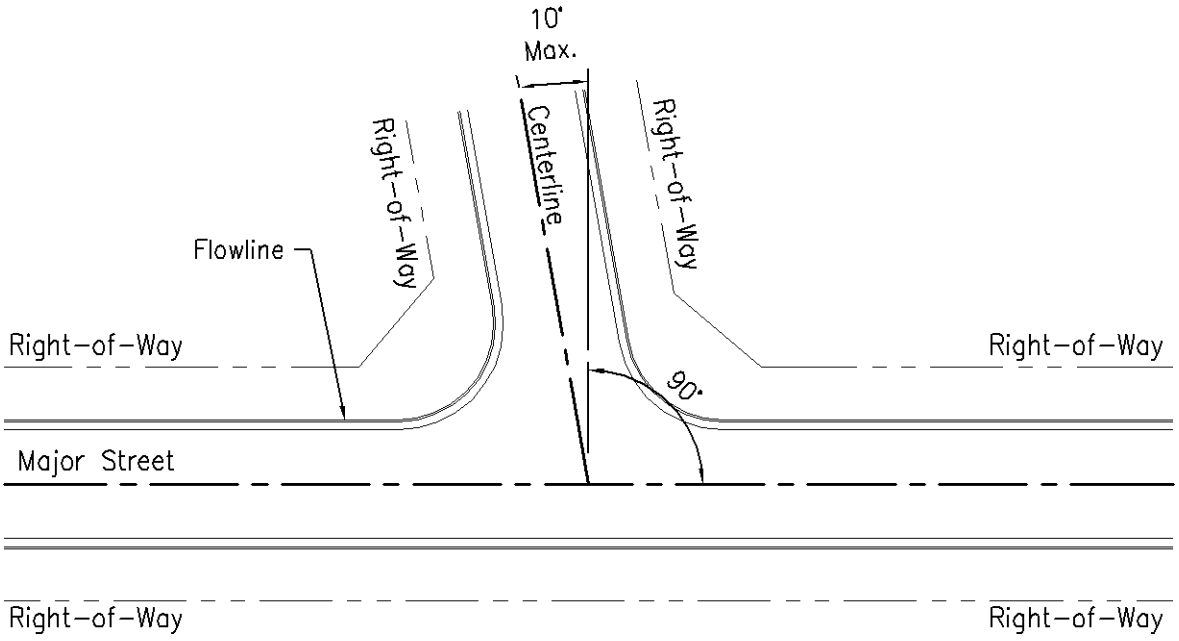
The elevation at the PCR of the curb return on the through street is always set by the grade of the through street in conjunction with a normal pavement cross slope of 2%. Carrying the crown at a side street into the through street is permitted only when drainage considerations warrant such a design. Refer to Section 7.8.3 for street cross slope allowances.

A more detailed review shall be performed for Arterial-Arterial intersections to maximize drivability. Few Arterial intersections will have a uniform 2% cross slope, the majority of them having one or more sides warped (refer to Sections 7.8.3 of these Standards for rates of pavement warp allowed). A plan view drawing of all Arterial-Arterial intersections will be required showing spot elevations on a 10-foot-by-10-foot grid.

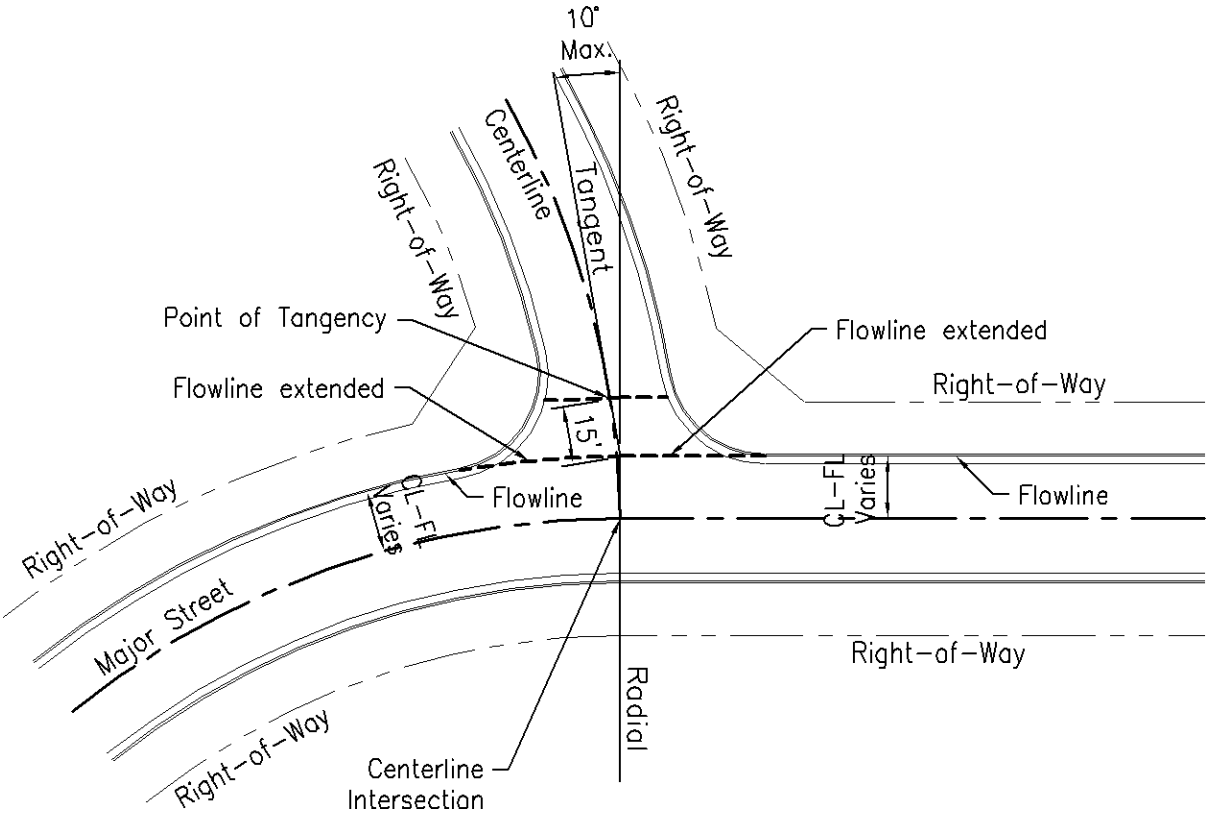
Whenever possible, intersections shall be made at right angles or radial to a curve. An intersecting deflection angle of more than 10% will not be allowed (refer to Figure 7-25). Intersection sight distances shall conform to the requirements of these Roadway Standards or the AASHTO Green Book, or both.

Refer to Figure 7-22 for an example of the Permissible Intersection Grade.

Figure 7-25. Permissible Intersection Angle



Intersection of a Straight Street to a Straight Street



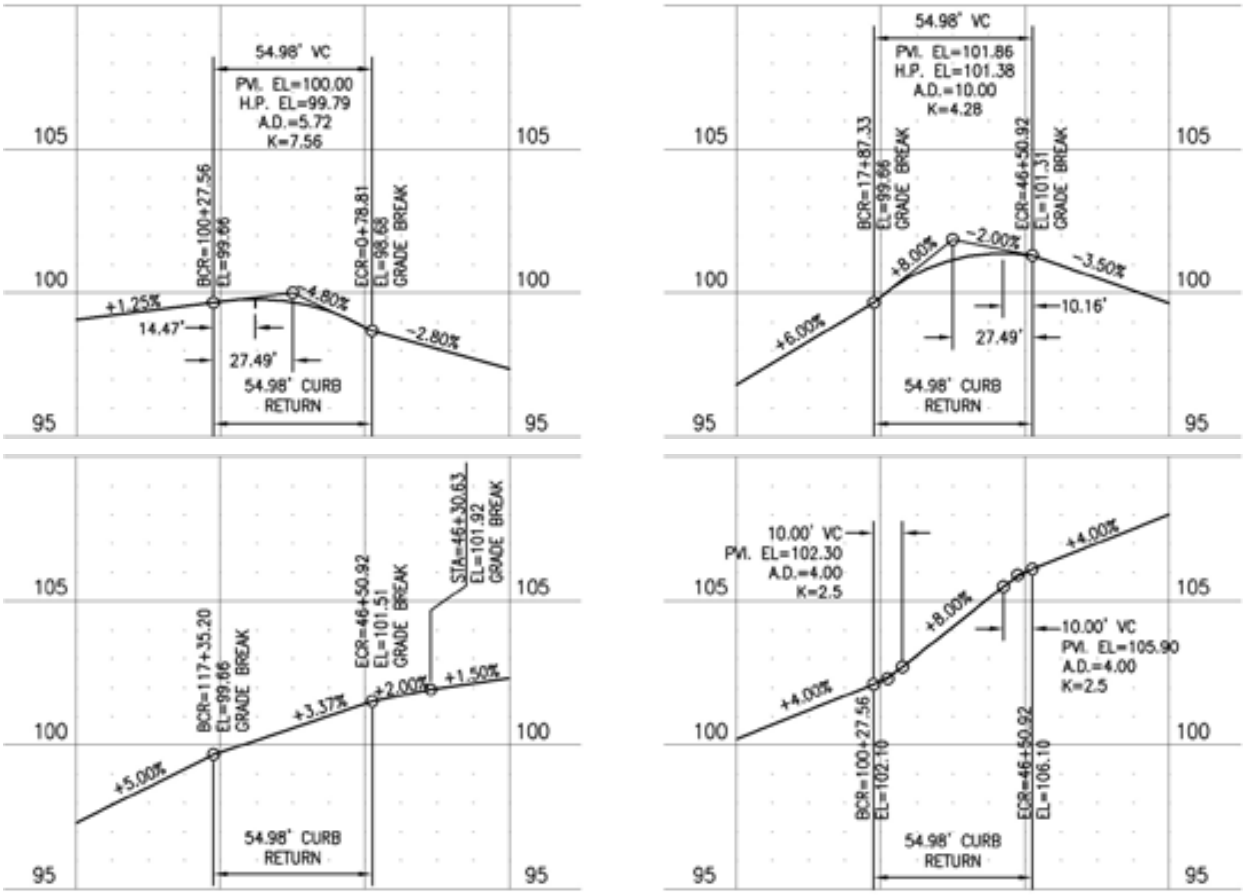
Intersection of a Curve Street to a Curve or Straight Street

7.9.1 Curb Returns

Curb return profiles are required for all curb returns within the public right-of-way. An elevation along the arc length of the curb return shall be shown in plan view at both sides of handicap ramps. Curb return profiles shall be extended 100 feet in each direction to create an adequate design with impacted roadways. General standards for flowline control and profiles within the curb returns shall be as follows:

- The point of tangency at each curb return shall be determined by the projected tangent grade beginning at the point of intersections of the flowlines.
- Design the flowline of the curb return such that the maximum slope along the flowline does not exceed 8%.
- Grade breaks at the PCRs shall not exceed 2% for Local and Collector streets and 1% for Arterials.
- Maximum vertical curve length will equal the arc length of the curb return.
- The elevation and location of the high or low point within the return, if applicable, is to be called out in the profile.
- Warp of the side streets shall not exceed criteria set in Section 7.8.3.

Figure 7-26. Curb Return Examples



Rules to follow for designing curb return profiles:

1) Grade break at PCR only.
2) Minimum grade around a curb return is 2%; maximum grade is 6%.
3) Roadway cross slope cannot exceed 4%.

7.9.2 Connection with Existing Roadways

If the algebraic difference in grade between the existing and proposed grade exceeds 0.5%, a vertical curve will be required to make this transition (refer to Section 7.8.4). The vertical curve shall end prior to the connection with the existing improvement and also comply with the grade requirements at intersection approaches.

Existing grade shall be shown for at least 300 feet, with field-verified as-builts showing stations and elevations at 25-foot intervals. In the case of a connection with an existing intersection, these as-builts are to be shown within a 300-foot radius of the intersection. This information will be included in the plan and profile for the proposed roadway.

Limits and characteristics of the existing improvement are the primary concern in the plan view. Such characteristics include horizontal alignment, offsite intersections, and limits of the improvement, among others.

The vertical datum of the as-built elevations shall be the same as the design elevations.

7.9.3 Intersection Warping

Refer to Section 7.8.3. for the rate of change in pavement cross slope.

7.10 Roundabouts

7.10.1 General Guidelines

The City may allow Roundabouts to replace other types of intersection traffic control, such as two-way or all-way STOP signs or traffic signals. They may be considered at any location where a Roundabout is shown to operate as well or better than a signal if the Roundabout can be constructed to meet City standards. Roundabouts are limited to roadways with no more than two approach lanes (4- to 5-lane roadways).

All Roundabout designs shall require a two-step process: (1) a preliminary design and feasibility analysis initially submitted to the City Public Works Department, and (2) a construction design where specific design criteria and standards are reviewed.

All proposed Roundabouts fall within three categories: (1) mini-Roundabouts, which are small, one-lane Roundabouts that can be used as traffic-calming devices and are limited to Local roads only; (2) single-lane Roundabouts, which are often used to replace four-way STOP control or traffic signals on all classifications of roadways with two travel lanes; and (3) multi-lane Roundabouts, which are used to replace a traffic signal on four-lane roadways.

Roundabouts may have three, four, or five approaches. Approach roadways may be single lane, single lane with a flare out to provide an added left-only or right-only lane at the circulating roadway, single lane with a by-pass right-turn lane, or two lanes without added lanes. The configuration must be based on turning movement volumes and provide balanced lane use.

7.10.2 Feasibility Analysis

Prior to beginning design of the Roundabout, a feasibility analysis must be prepared that includes at a minimum the following:

- Traffic Operations Study consisting of daily volumes, vehicle classification, and a.m./p.m. peak hour turning movement counts for existing site buildout and a 20-year forecast. Where the Roundabout is near a school, shopping center, or other major traffic generator, the peak hour for local traffic with the traffic generator fully developed shall be used.
- Location and category of the proposed Roundabout, including roadway widths, speeds, and classifications for intersecting roadways.
- Preliminary dimensions of the Roundabout, including inscribed circle and circulating roadway, number of lanes for each approach and departure, existing and planned pedestrian and bicycle facilities in the immediate area, and right-of-way.
- Preliminary approach grades.
- Identification and proposed method of correcting any restrictions to visibility on each approach caused by vertical or horizontal alignment design or other sight-distance restrictions.
- LOS analysis from RODEL, SIDRA, or ARCADY (minimum LOS C or better at 85% confidence level) and comparison with alternatives (signal, four-way, or two-way STOP, using Synchro or Highway Capacity Software) at initial construction and with 20-year projections.
- Identification of impact on any nearby intersections, driveways, or traffic signals caused by queuing.
- Identification of any expected construction or phasing problems and proposed mitigation.

7.10.3 Design

The design shall include the following:

- A location map and details of the approach roadways (such as width, grades, number of lanes, drainage patterns, lighting, and typical Roundabout design criteria).
- Sight-distance lines for Decision Sight Distance. The approach roadways must provide drivers with adequate visibility of the Roundabout from a distance that shall allow approaching drivers to see and identify the Roundabout, both day and night. The Decision Sight Distance is the minimum distance required to allow deceleration from the 85th percentile travel speed (or posted speed limit, whichever is greater) to the maximum entry speed of 20 mph (single lane) or 25 mph (multi-lane) without exceeding a deceleration rate of 10 feet per second squared. This is generally the same distance as the "intersection sight distance" noted in AASHTO standards and is variable by approach speed.
- Stopping Sight Distance lines and restricted sight areas for each approach.
- A separate drawing showing turning templates for large vehicles and fastest path lines.
- Drainage patterns on the approaches and within the Roundabout.
- Signage and pavement markings for vehicles and pedestrians.
- Where bike lanes exist or are planned, provision of ramps for bicyclists to enter sidewalk and navigate Roundabout as a pedestrian.
- Location of existing and proposed utilities.

See Appendix A for specific design details regarding alignment, grades, and other Roundabout-specific design criteria.

7.11 Sight Distance

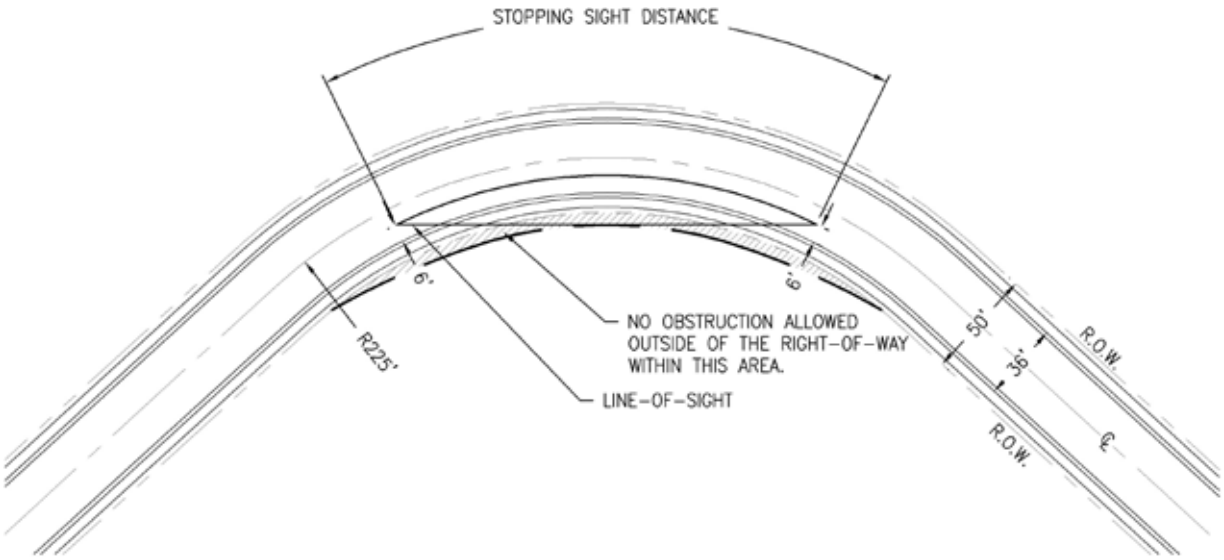
The horizontal and vertical alignment must provide at least the minimum sight distance for the design speed at all points. This includes visibility at intersections as well as along all horizontal and vertical curves. All sight distance lengths shall be adjusted for any grade 3% or higher per AASHTO.

7.11.1 Sight Distance on Horizontal Curves

Horizontal sight distance on the inside of a curve can be limited by obstructions, such as buildings, hedges, wooded areas, high ground, and utility boxes. These obstructions shall be shown on the plans. Horizontal sight is measured as indicated on Figure 7-27.

Cut slope obstructions shall be shown on the plans by a line representing the proposed excavation slope at a point 2.75 feet above the road surface for stopping sight distance and at a point 3.5 feet above the road surface for passing sight distance. The position of this line with respect to the centerline may be scaled from the plotted roadway cross sections. The stopping sight distance shall be measured between points on the same traffic lane and passing sight distance from the middle of one lane to the middle of the other lane.

Figure 7-27. Lateral Clearance to Sight Obstruction inside of Horizontal Curves Providing Stopping Distance for Turning Roadways



7.11.2 Stopping Sight Distance

The minimum stopping sight distance is the distance required by the driver of a vehicle traveling at the design speed to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is calculated in accordance with the AASHTO Green Book. Object height is 2 feet above road surface and viewer's height is 3.5 feet above road surface.

In no case shall the stopping sight distance be less than as specified in Table 7-3. A likely obstruction may be a bridge abutment or line of columns, wall, cut-side slope, landscaping, or the side or corner of a building. The sight distance design procedure shall assume a 6-foot fence (as measured from actual finished grade) exists at all property lines except in the line of sight required at all intersections. (Refer to Figure 7-27).

The position of the driver's eye and the object sighted are assumed to be 6 feet from the inner edge of pavement, with the sight distance being measured along this arc.

7.11.3 Passing Sight Distance

Passing sight distance is the minimum sight distance that must be available to enable the driver of one vehicle to pass another safely and comfortably without interfering with oncoming traffic traveling at the design speed. Required passing sight distance for given design speeds is shown in Table 7-3.

Table 7-3. Stopping and Passing Sight Distance

Design Speed (mph)	Stopping Sight Distance (feet)	Passing Sight Distance (feet)
20	115	400
25	155	450
30	200	500
35	250	550
40	305	600
45	360	700
50	425	800
55	495	900
60	570	1,000
65	645	1,100
70	730	1,200

Source: AASHTO Green Book

7.11.4 Intersection and Driveway Sight Distance

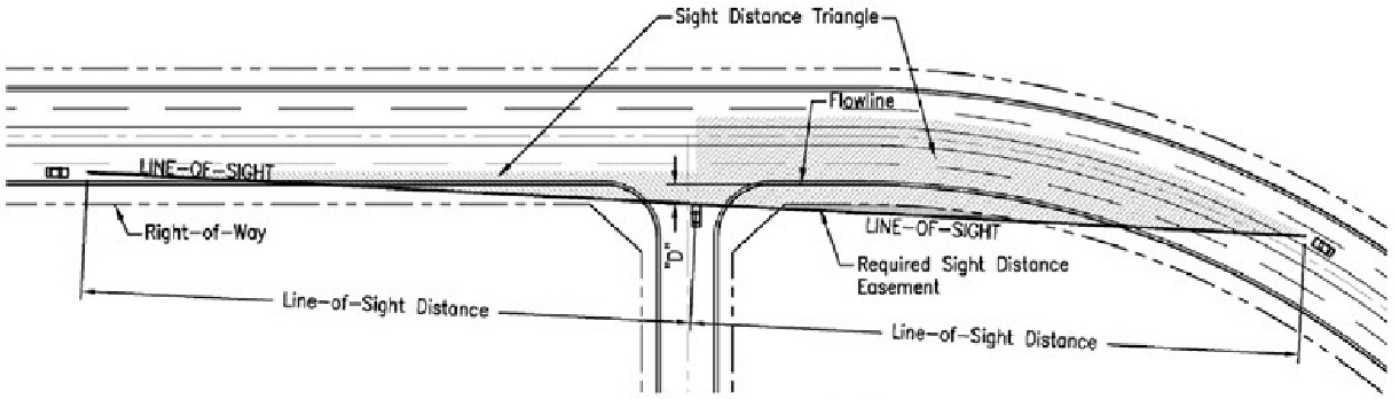
There shall be an unobstructed line-of-sight along both sides of all stopped approaches at an intersection within the right-of-way to provide the entering vehicle adequate sight distance to enter or cross the roadway. Refer to Figure 7-28.

Any object within the sight triangle (Figure 7-28) more than 24 inches above the flowline or edge of pavement elevation of the adjacent street shall constitute a sight obstruction and shall be removed or lowered. Such objects include berms, retaining walls, signs, buildings, cut slopes, hedges, trees, bushes, utility cabinets, or tall crops. These Roadway Standards also require the elimination of parking (except on local streets or as otherwise permitted by the City) within the sight triangle and applies whether the intersecting roads are level or on grades. The sight distance shall be measured to the centerline of the closest through lane in both directions.

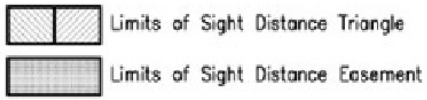
All sight-distance triangles must be shown on the street plan/profile and landscape plans. All sight distance must be within the right-of-way. Any sight distance triangle outside of the right-of-way must be accepted by the City Public Works Department and requires a sight-distance easement.

In no case shall any object encroach into the line-of-sight of any part of the sight distance triangle. Refer to Figure 7-29.

Figure 7-28. Intersection and Driveway Sight Distance (Line-of-Sight Triangle)



City of Castle Pines Road Classification	Design Speed (mph)	Posted Speed Limit (mph)	Line-of-Sight Distance (FT)
Cul-de-Sac	25	20	230
Local	30	25	280
Entry Street	30	25	280
Commercial and Industrial	30	25	280
Major and Minor Collector	35	25	280
Minor Arterial	50	40	583
Principal Arterial	50	40	583



Notes:

Line-of-Sight distance is measured from a point on the Minor road at 15 feet back from the flowline of the Major road to the closest oncoming lane.

Line-of-Sight distance is measured from a height of eye at 3.50 feet on the Minor road to a height of object of 2.00 feet on the Major road.

At Local-Local street intersections only, the "D" dimension shall be 10 feet and the sight distance shall be measured to the center of the lane.

For private driveway access to a public street, use 10 feet back from the flowline (or shoulder for gravel roads).

For 60 mph Design Speed, stopping sight distance governs.

Line-of-Sight must be within the right-of-way or easement.

Sight distance developed from the AASHTO Green Book.

Line-of-Sight distances may need to be adjusted if special traffic control conditions exist per the AASHTO Green Book.

7.11.5 Sight Distance on Vertical Curves

The vertical sight distance should be checked to verify that the sight distance is sufficient to allow a vehicle to stop, pass, or enter.

Methods for scaling sight distances are demonstrated on Figure 7-29. The figure also shows a typical sight-distance record that would be shown on the final plans for Collector and Arterial roads. Both horizontal and vertical sight distances should be measured, and the shorter lengths shall be considered the critical sight distance for use in design. It is desirable to measure and record sight distance for both directions of travel at each station. In the case of rural two-lane streets, passing sight distance in addition to stopping sight distance should be measured and recorded. Once the horizontal and vertical alignments are tentatively established, the practical means of examining sight distances along the proposed street is by direct scaling on the plans. Refer to Figure 7-29.

7.12 Offsite Design

The design grade and existing ground of all roadways that dead-end as a result of project phasing, subdivision boundaries, and the like shall be continued, in the same plan and profile as the proposed design. If the offsite roadway adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of a transition for the safe conveyance of traffic from the improved section to the existing roadway.

7.13 Auxiliary Lanes

The design of the arterial street system depends on the proper control of access to developments. Auxiliary Lanes shall be designed using the CDOT Design Guide. The need for Auxiliary Lanes on two-lane roads shall adhere to the State Highway Access Code. The need for all other Auxiliary Lanes will be established by the accepted traffic impact study for the final plat or final development plan. Lane widths are a minimum of 12 feet, including the adjacent curb and gutter pans.

7.14 Bus Pullout Lanes

Bus Pullout Lanes shall be designed and constructed by the adjacent land developers where required. The design of the Bus Pullout Lanes will be governed by dimensions shown in Table 7-4, located on the far side of an intersection, and shall be reviewed and accepted according to procedures set forth in these Roadway Standards.

Table 7-4. Bus Pullout Lanes

Speed Limit (mph)	Lead-in Length (feet)	Lead-out Length (feet)
35 and under	60	60
40	100	70
45	150	80
50	200	90
55	250	100

Actual dimensions shall conform with criteria set forth by the Regional Transportation District. The Pavement Design Report (See Chapter 10 of these Roadway Standards) shall consider the requirements of the Bus Pullout Lane separately from the adjacent roadway. All Bus Pullout Lanes must be concrete, which will conform to all applicable paving criteria. Bus Pullout Lanes shall be constructed with no less than 50 feet between an intersection PCR and the beginning of the lead-in taper.

Figure 7-29. Scaling and Recording Sight Distance on Plans

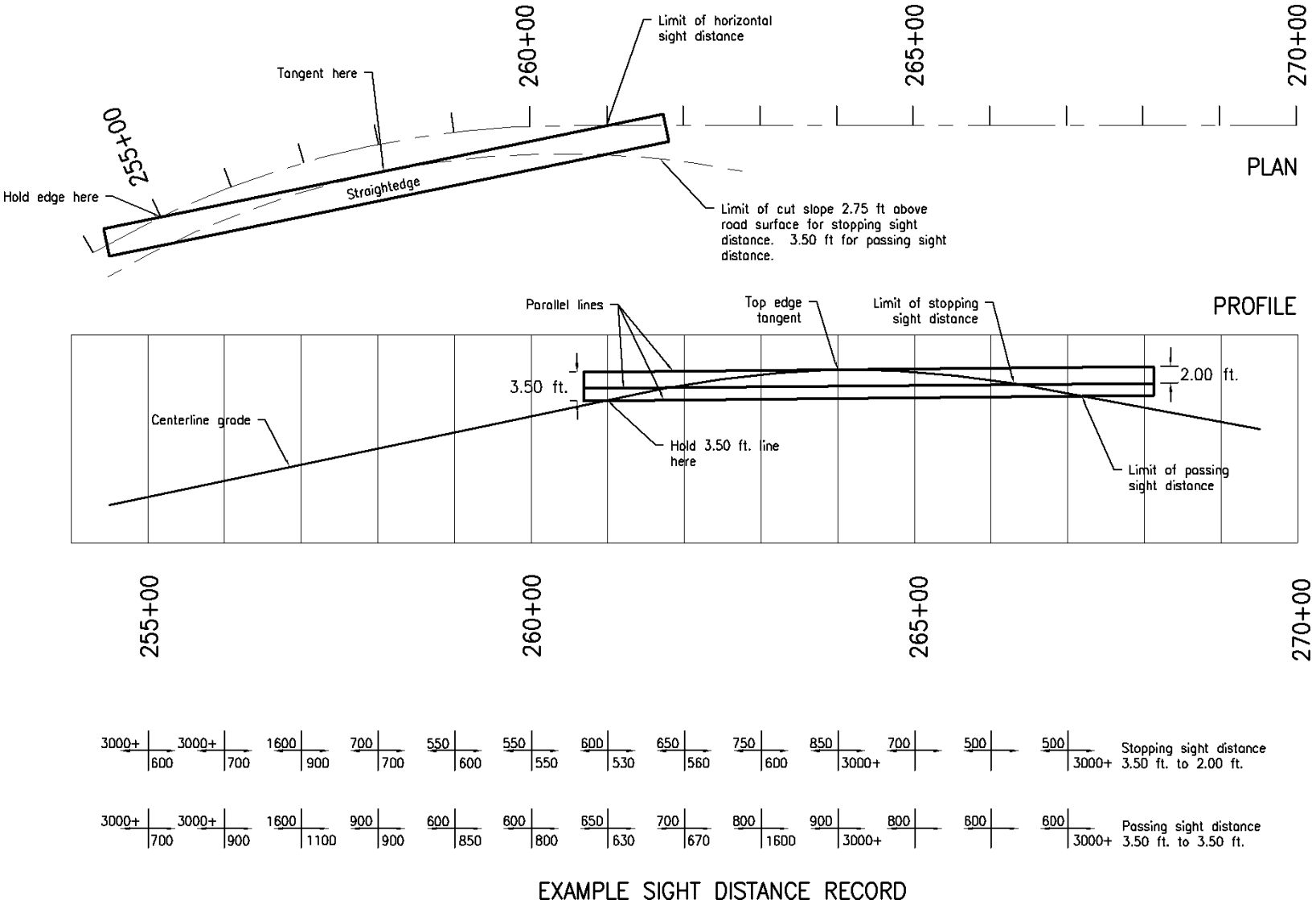
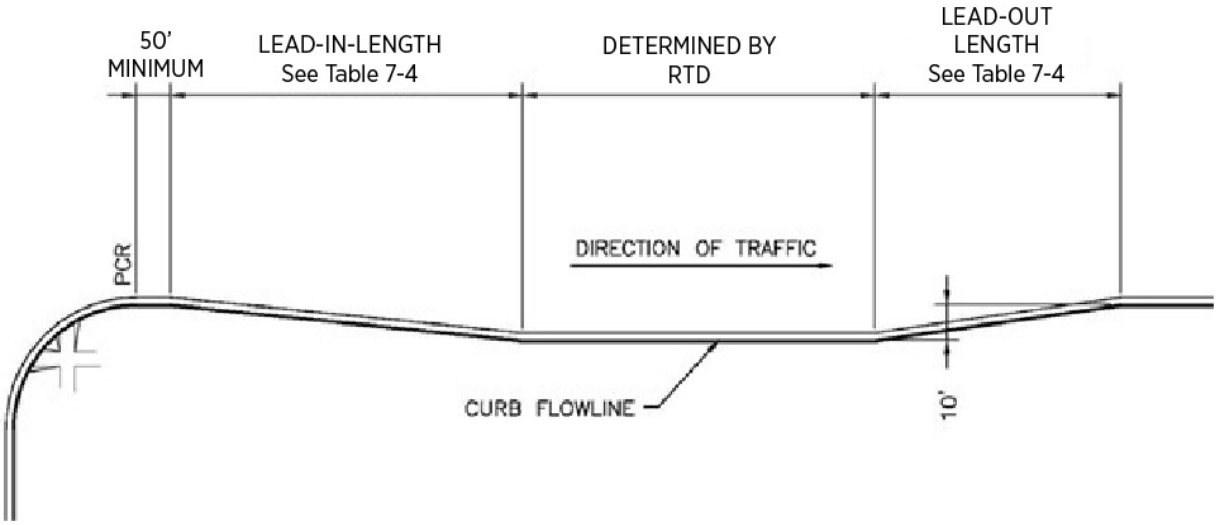


Figure 7-30. Bus Pullout Lane



7.15 Raised Medians

7.15.1 Median Islands

No permanent structures (for example, trees, poles, and large rocks) shall be placed within 10 feet of the face of curb (unless the median is constructed in accordance with the Median Planter Standard Drawings of these Roadway Standards) or in any location that would obstruct sight distance.

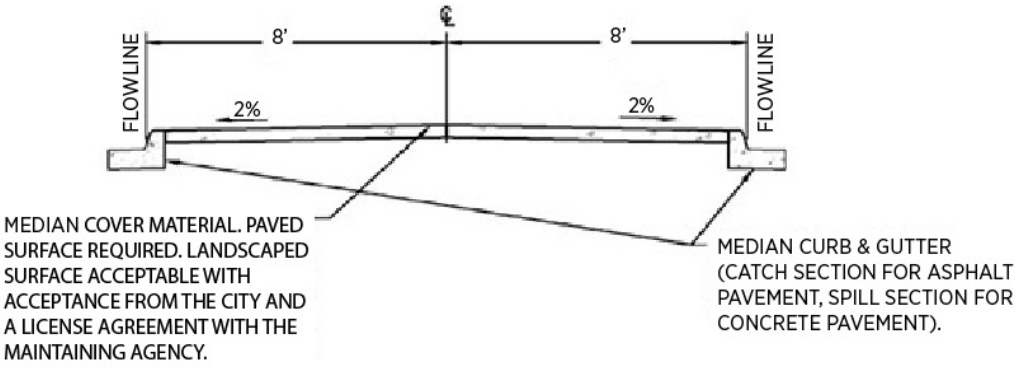
Landscaping on median islands shall have a mature height of 24-inches or less above the flowline of the adjacent street in areas around intersections to facilitate adequate sight distance and must be dry land or native vegetation. If irrigation is planned in a median island, trench drain will be provided to protect the subgrade under the pavement from being saturated by using the Median Planter detailed in Appendix A.

For all streets constructed with asphalt, the median shall be constructed with a catch curb and gutter. Inlets are required along the median to reduce ponding at curb and gutter low points and to eliminate concentrated flow crossing over the lanes of traffic at the nose of the median. The final design and construction drawings must address inlet sizing, dimensions, and required curb and gutter transitions. If a street is constructed with concrete, it is acceptable for the median curb and gutter to be constructed as a spill section. Refer to the Storm Design Manual, which presents conceptual representations of options available for placing median nose inlets.

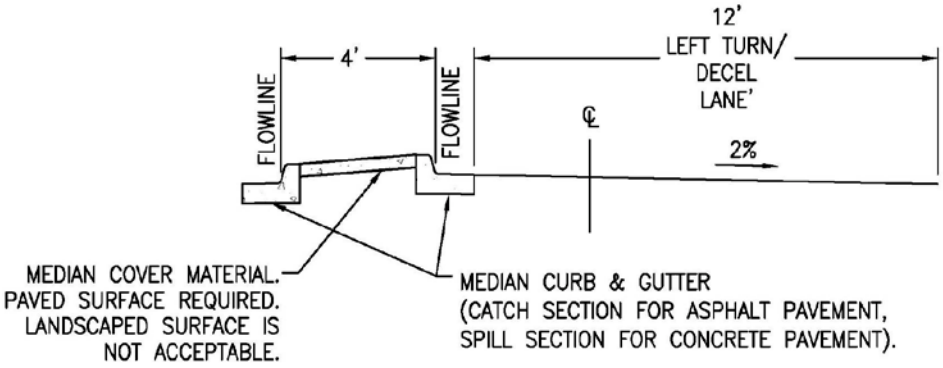
The nose of the median island shall not extend past the PCR for the curb return at any intersection.

A minimum 20-foot flowline to flowline street cross-section must be maintained on both sides of all median islands.

Figure 7-31. Median at Intersection

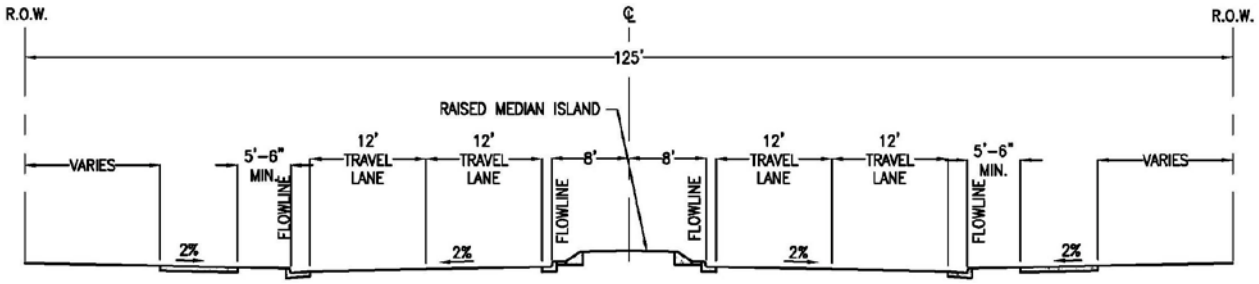


Full Width

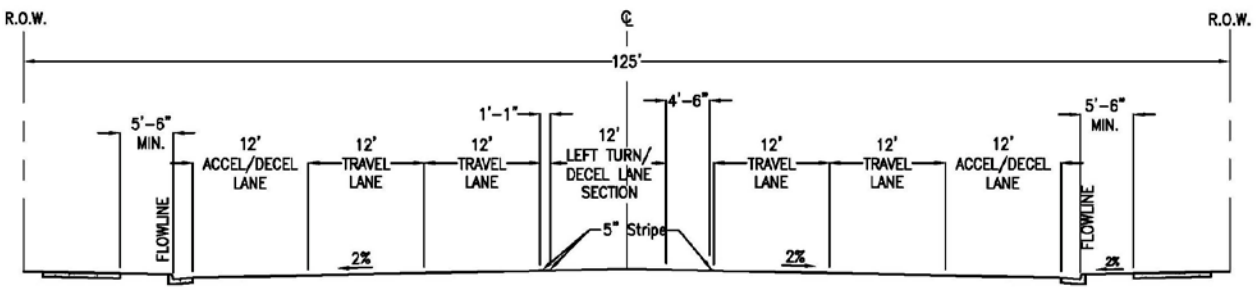


Left-Turn Lane

Figure 7-32. Intersection Striping Option for Single Left Turn

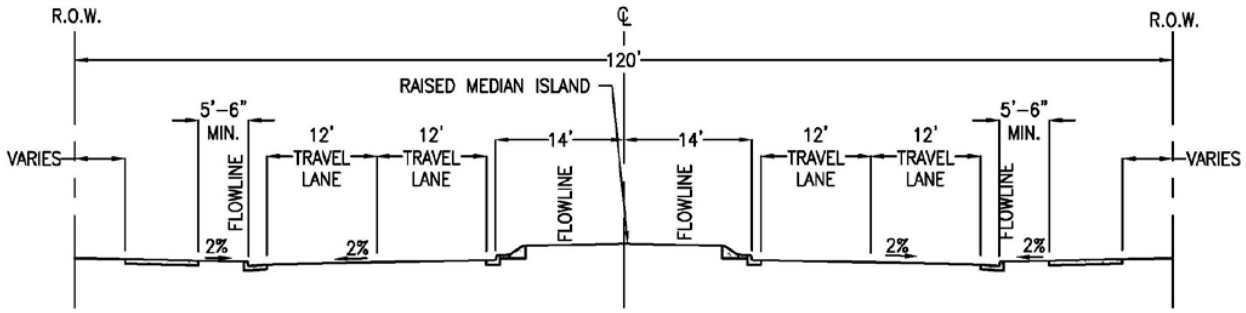


Road Section

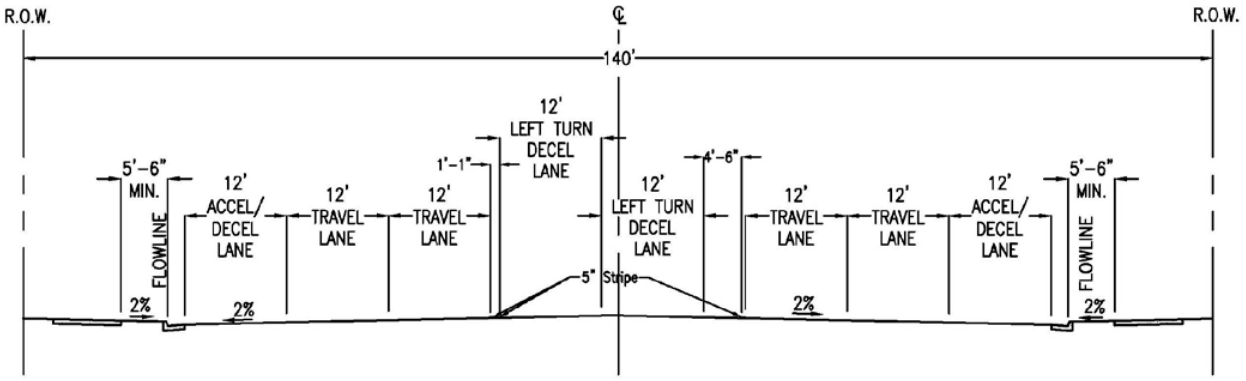


At Intersection

Figure 7-33. Intersection Striping Option for Dual Left Turn



Road Section



At Intersection

7.16 Right-of-Way Maintenance

If landscaping within, or encroaching into, the City right-of-way is restricting sight distance, is blocking a traffic control device, or is otherwise a hazard, according to City of Castle Pines criteria, the City may (by written notice sent by certified mail in accordance with CRS 42-4-114) require the owner of real property abutting the right-of-way to trim or remove, at the expense of said property owner, any tree limb, shrub, vine, hedge, or other plant on their property that projects beyond the property line into or over the public right-of-way. In the event that the property owner fails or neglects to trim or remove any such obstruction, within 10 days after receipt of said written notice, the City may remove said obstruction, and said property owner shall reimburse the City for the cost of the work performed.

Mailboxes constructed in the City right-of-way must conform to the standard details. Brick or stone column mailboxes are considered a vehicular obstruction and are not allowed in the City right-of-way unless a variance with a License Agreement is granted.

The term "Clear Zone" is used to designate the unobstructed, traversable area provided beyond the edge of the traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bicycle lanes, and auxiliary lanes unless the auxiliary lane functions like a through lane. Refer to the AASHTO Roadside Design Guide for further guidance.

The Standards allow for street lighting in public right-of-way. City of Castle Pines is not responsible for installation, replacement, maintenance, removal or power costs, unless otherwise agreed to in writing. Generally, such responsibilities shall be the obligation of the adjacent development.

7.17 Private Streets

7.17.1 City Requirements

The City is required by State Statue to review all subdivision of property to confirm that the designs meet all sound planning and engineering requirements as contained in the City Subdivision Regulations. The City is further charged to guarantee the public improvements of the subdivision are constructed and that said construction is in substantial conformance with the plans and specifications. The Colorado Revised Statues state, "All plans of streets or highways for public use, and all plans, plats, plots, and replots of land laid out in subdivision or building lots and the streets, highways, alleys, or other portions of the same intended to be dedicated to a public use or the use of purchasers or owners of lots fronting thereon or adjacent thereto, shall be submitted to the planning commission or City Council for review and subsequent approval, conditional approval, or disapproval."

7.17.2 General Application

All roadways shall be built to these Roadway Standards. If an Owner or Developer wishes to not build the roadways to City standards or with adequate rights-of-way, the Owner or Developer shall submit Private Roadway Standards for review by the City. If the Private Roadway Standards are acceptable to the City, then these roadways shall not be maintained or assumed for maintenance by the City unless they are brought to City standards at the Owner's or Developer's expense.

7.17.3 Private Improvements

Private improvements, such as roadways, driveways, or utilities, shall be clearly shown and labeled as such on each sheet of the construction plans. The following note shall appear on each sheet of the constructions plans where private improvements are shown: "City of Castle Pines shall not be responsible for the maintenance of roadway and appurtenant improvements, including storm drainage structures and pipes, for the following private streets."

When a request is made for the City to assume maintenance of any private improvement, it shall be the responsibility of the person(s) making the request to satisfactorily demonstrate that the private improvement is constructed in accordance with these Roadway Standards and that adequate right-of-way is provided.

The City will review these requests under normal review procedures as outlined previously in these Roadway Standards.

Improvements that were not constructed in accordance with the applicable design and construction standards and specifications will not be accepted for maintenance by the City.

Any gate on a private road shall be located a minimum of 30 feet from the outside edge of the closest through lane of the intersecting road. The opening of the gate must be a minimum of 2 feet wider than the gated road or greater as required by the local Fire District.

7.17.4 Private Roadway Standards

Private roadway standards, based on Sound Engineering Criteria, may be proposed for private development. These private roadway standards must be certified as to their adequacy and safety by a Professional Engineer licensed in the State of Colorado. The private roadway standards must contain a list of all deviations from City criteria as well as references to all sources that support the adequacy of the proposed deviations. The Standards shall be subject to acceptance by the Developer, governing Fire

District, and the City. The following statement needs to be included on the acceptance page of the private roadway standards: "Private roads shall not be maintained or assumed for maintenance by City of Castle Pines unless right-of-way is dedicated to the City in fee simple at no cost to the City, and the private roads are improved to meet the requirements of the City of Castle Pines Roadway Design and Construction Standards, as amended, at no cost to the City. Additional requirements may apply."

7.17.5 Pavement Design/Roadway Construction

All roadways constructed in the City shall be high-quality, minimum maintenance roads, that meet or exceed established City of Castle Pines specifications with respect to pavement thickness, composition, and base as set forth in these Roadway Standards.

7.17.6 Cost Estimate and Improvement Agreement

Any Developer or Applicant for Final Plat approval must provide the Community Development Department with an itemized cost estimate of all improvements (as defined by state statute) associated with the subdivision (to be titled Exhibit A). Cost estimates are to establish the amount of collateral provided by the Applicant to secure the SIA-Private. An amount equal to 15% of the total Cost Estimate shall be added to the total cost to cover construction contingencies. The Developer or Applicant shall guarantee all improvements, including those to be constructed by a District, unless an Intergovernmental Agreement has been executed between City of Castle Pines and the District, guaranteeing the construction of those Public Improvements committed to by the District. After review and acceptance of the Cost Estimate by the City Public Works Department, it is incorporated into the SIA-Private document. The SIA-Private document should be executed by the Developer or Applicant prior to the City Council hearing scheduled for the Final Plat approval. Collateral must be provided by the Developer or Applicant in the form and amount defined in the SIA-Private. Refer to Chapter 2, Submittals for additional information.

7.17.7 Inspection Requirement

During construction, a City Public Works Department Inspector may inspect private roads. Inspection or Permit fees will be charged. During construction, a City Public Works Department Inspector will inspect all erosion control measures and storm sewer facilities (that is, inlets, pipes, detention, and water quality facilities). Inspection or Permit fees will need to be collected prior to beginning work. Where utilities are installed to serve private developments and are located in easements or private street rights-of-way, those utilities will not require a Permit or associated fees from the City. Responsibility for inspection will rest with the utility company providing service, or the Developer or Applicant, or both.

7.17.8 Warranty Requirements

For subdivisions with private roads, sufficient guarantee must be given to the City in the form of test reports, field reports, and as-built drawings in conformance with the requirements in these Roadway Standards (including cores, density tests, and compaction reports) and certified by a PE licensed in the state of Colorado. Reports and as-built drawings must be submitted and accepted prior to release of securities in accordance with these Roadway Standards.

Chapter 8 - Structures, Bridges, and Retaining Walls

8.1 General

8.1.1 Structures

The City of Castle Pines has developed requirements for the design and construction of certain structures within the City. They include bridges, large culverts and other major drainage structures, retaining walls, and guardrails.

8.1.2 Guardrails

The design, location, and necessity of guardrails for bridge and roadside obstruction situations, as well as design of the same, shall be in accordance with the latest edition of the AASHTO Roadside Design Guide.

8.1.3 Pedestrian/Bicycle Railings

Railings shall be required at, and continuously along, sidewalks or multimodal paths where there are vertical separations of 30 inches or greater, or on slopes greater than or equal to 3:1 adjacent to these walks and paths. For low-water crossings, Mile High Flood District (MHFD) design guidelines may apply.

8.1.4 Retaining Walls

Retaining walls shall be required whenever slopes exceed 3 feet of run to 1 foot in rise (3:1). Refer to Section 1807.2 of the International Building Code for additional design criteria. Slopes to be revegetated and to be maintained by the landowner shall not exceed 4 feet of run to 1 foot of rise (4:1).

1) Retaining Wall Heights
    a) Detention, retention, and water quality ponds shall not have retaining walls exceeding 48 inches, unless the City determines there is an issue of aesthetics, in which case the maximum wall height will not exceed 72 inches. Railings may be required along the top of these walls. This requirement will be determined at the time of civil plan submittal.
    b) Residential Development
        i) Maximum 48 inches in height adjacent to rear lot lines
        ii) Maximum 30 inches in height adjacent to side lot lines
        iii) Maximum 30 inches in height in front yards and side yards for corner lots
        iv) Maximum 48 inches in height in all common areas
        v) Terraced retaining walls are not permitted within the side yards of single-family detached homes
2) Other Retaining Wall Heights
    a) All other retaining wall heights shall not exceed 8 feet. Walls shall be terraced until the required amount of slope has been taken up. Slopes between walls shall not exceed 4 feet of run to 1 foot of rise (4:1).
3) Railings
    a) Railings may be required along the top of walls. This requirement will be determined at the time of civil plan submittal. The design of retaining walls, wing walls, and miscellaneous structures that are unattached and not considered part of a building shall be submitted with the Civil

Construction Plans to the City. The design for walls attached to and part of a building, or for walls that a building is structurally dependent on, shall be submitted to the City for review.

4) Details

   a) Details are required on all retaining walls at bridges and structures and shall be included on the drainage or grading drawings.

5) Retaining walls, miscellaneous structures, wing walls higher than 4 feet from grade or adjacent to easements, public rights-of-way, or fire lanes that intrude on a line projected at 3:1 (H:V) slope from the easement line, right-of-way line, or edge of a fire lane shall be designed, signed, sealed, and dated by a Professional Engineer (PE) licensed in the State of Colorado before review by the City.

6) Concrete poured-in-place retaining walls shall be designed and submitted along with the first submittal of the civil construction drawings for the development. The structural calculations shall be included in the first civil construction drawing submittal.

7) Terraced retaining walls with a total vertical height greater than 4 feet shall be designed, signed, sealed, and dated by a PE licensed in the State of Colorado before City review. If the horizontal distance between the terraced walls is less than twice the height of the lower wall (even if the individual walls are less than 4 feet high), the following criteria apply:

   a) The entire terraced wall height shall be considered to act as one wall and shall be designed as one wall.

   b) Each terrace of the wall can be designed individually, as long as such design is accompanied by a Global Stability Analysis performed on the entire terraced wall height. Retaining walls used to support a roadway, driveway, or structure shall be designed, and the plans sealed, signed, and dated by a PE licensed in the State of Colorado. Guardrails, pedestrian railings, or both, shall be included with the design. Mechanically stabilized earth walls shall not have any tie-backs within the public right-of-way, unless approved in advance by the City.

8) Retaining walls along sidewalks, trails, wing walls, and head walls exceeding 30 inches in height require railings. Retaining walls along bicycle trails require bicycle railings. Bicycle railings must be designed in accordance with the latest edition of American Association of State Highway and Transportation Officials' (AASHTO) Guide for the Development of Bicycle Facilities.

9) A retaining wall Permit shall be obtained from the City prior to constructing any retaining walls.

10) When retaining walls are not cast-in-place retaining walls, the walls are greater than 4 feet in height, or there are terraced retaining walls where the horizontal distance between the walls is less than twice the height of the lower wall (even if the individual walls are less than 4 feet in height), then the contractor must submit structural calculations (and details as needed on 24-inch-by-36-inch drawings) to the City for review and approval prior to pulling a Permit to construct those walls.

11) Private retaining walls within and along public rights-of-way or easements require a license agreement.

8.1.5 Bridges

Bridge structures shall be designed and constructed in accordance with the latest Colorado Department of Transportation (CDOT) Standards and Specifications.

8.1.6 Drainage Structures and Culverts

Drainage structures shall be designed in accordance with the latest CDOT Standards and Specifications, as well as MHFD.

Chapter 9 - Signage, Pavement Markings, and Traffic Signals

9.1 General Requirements

Signage, pavement markings, and traffic signals shall be designed and installed in accordance with the City of Castle Pines Standards. All traffic control devices shall conform to the most recent version of the federal *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), the Colorado Supplemental MUTCD, and the Castle Pines Roadway Design and Construction Standards Manual. Further specifications and illustrations can be referenced in the Colorado Department of Transportation (CDOT) Standards.

Notes on signage and pavement markings shall be included in all sets of construction plans. Permanent signage and striping shall be completely in place before any new roadway is opened to the public. The City Public Works Department shall perform a field inspection of location and installation of all signs and markings prior to completion and acceptance of the work. All discrepancies identified during the field inspection must be corrected before the 2-year warranty period will begin.

9.2 Traffic Signage Criteria

9.2.1 Sign Blanks

Aluminum blanks shall be 0.080 gauge.

9.2.2 Sign Sheeting

All STOP (R1-1) signs, YIELD (R1-2), and overhead signs mounted on structures shall have ASTM D4956 Type VII retroreflective material (3M Diamond grade or approved equivalent). All other ground signs shall have ASTM D4956 Type III retroreflective material (3M High Intensity Prismatic grade or approved equivalent).

9.2.3 STOP Sign Size

Where STOP sign control is appropriate, 36-inch STOP signs shall be used for approaches to any roadway that is classified as a Major or Minor Collector or greater.

9.2.4 Street Name Signs

For all new streets, the street names are to be obtained from Douglas County for all intersections.

Street name signs shall be limited to 12 letters/characters, excluding street type prefix and suffix. All street name signs shall be visible from both directions, and the legend shall be affixed to both sides of the sign panel.

A 7-foot minimum height shall be maintained from the bottom of the sign panel to the top grade of the sidewalk (at top grade of pavement edge where no sidewalk exists). Refer to Standard Detail SS-1.

Refer to Standard Details SS-2 and SS-3 for street name assembly requirements and sizes. When street name assembly is combined with regulatory sign(s), minimum mounting height shall apply to the regulatory sign(s).

All street name signs shall be visible from both directions. If installing with a SignFix bracket and one panel, the legend shall be affixed to both sides of the sign panel.

All public road street name signs shall include the City of Castle Pines logo on the left side of the sign (except for allowances listed in Section 9.4). When arrows are used or required, the City of Castle Pines logo shall be omitted.

Street name sign coloring shall be white legend on green background, unless approved otherwise.

Special care shall be taken in the sign's location to create an unobstructed view of each sign.

All removed signs shall be returned to the City Public Works Department if requested.

Capital Improvement Program and Special projects for roadway improvements shall require all existing traffic signs to be replaced with new traffic signs. All signs shall be returned to the City Public Works Department if requested.

All sign locations shall be in accordance with the current version of the MUTCD or as approved by the City Public Works Department and placed in accordance with Standard Detail SS-1.

9.3 Posts and Anchor Posts

9.3.1 Ground-mounted Signs

Ground-mounted signs shall be mounted on standard 12-gauge, 2-inch-by-2-inch, galvanized square steel tube posts, all four sides punched with 3/8-inch holes at 1-inch centers. Posts must be of appropriate length to meet MUTCD specifications for the location and must meet Federal Breakaway Standards. Anchor posts are to be 2-and-1-quarter-inch by 2-and-1-quarter-inch by 3-foot square tubing with all four sides punched with 3/8-inch holes at 1-inch centers, driven down to 4 inches above grade. Longer anchor posts may be required by the City because of soil composition and compaction.

9.3.2 Island Signs

For all signs installed in raised median islands and Roundabouts and mounted in concrete, KLEEN BREAK MODEL 425 anchors also need to be installed (in accordance with Xcessories Squared Development and Manufacturing Inc. Drawing #XKB425-20-CI Square Post Sign Support Installation Instructions) at the time of island construction for all known future signs.

9.3.3 Large Signs

Xcessories Squared 1.25-inch Aluminum Sign Brace Non-Perforated (or equivalent) shall be used on all signs that are greater than or equal to 1,152 square inches (or as directed by the City Public Works Department). Install according to manufacturer's recommendations and specifications.

9.4 Criteria on Special Allowances for Street Name Sign Variances

Plans for any variances must be submitted to and reviewed by the City Public Works Department. Engineering-specific variances from City Standards must be listed in the special footnote box on the first page of the plans.

Only Metro Districts or Home Owners Associations (HOA) may apply for variances. The Metro District must submit a draft agreement to be reviewed by the City and the City Attorney.

The agreement shall be addressed to the City and must specify that the requesting Metro District shall be responsible for maintenance and supply in perpetuity of their specific signs and materials. The agreement must stipulate that the District/ HOA shall respond within 24 hours after notification by the City Public Works Department that maintenance or repair is required.

This agreement will be recorded in the City of Castle Pines; notification of the book and page number will be returned to the Metro District/ HOA.

9.5 Designer's Responsibility

These standards are intended for typical applications of signage and striping for standard conditions. These standards do not alleviate the responsibility of the designer from sound engineering judgment or from exceeding minimum standards in specific cases where conditions warrant.

9.6 Pavement Marking Criteria

9.6.1 Material

Standard pavement marking materials shall be as follows for all City roadways. All materials listed shall conform to the most recent edition of the CDOT Standard Specifications for Road and Bridge Construction, sections 627 and 713. Other pavement marking materials may be used as requested or approved by the City Public Works Department.

Table 9-1. Standard Marking Materials

Marking Type/ Surface Type	Edge, Lane, and Channelizing Lines	Crosswalk Bars and Stop Bars	Turn Arrows and Written Legends
Concrete Pavement	Modified Epoxy	Preformed Plastic[a] or Preformed Thermoplastic	Preformed Plastic or Preformed Thermoplastic
Asphalt Pavement	Modified Epoxy	Preformed Plastic or Preformed Thermoplastic	Preformed Plastic or Preformed Thermoplastic

[a] Crosswalk bars shall be recessed.

Note:

Preformed Plastic minimum thickness is 60 mils for legends and symbols, 75 mil minimum for stop bars and crosswalk bars.

Preformed thermoplastic may be used for spot repair or replacement of all marking types on asphalt surfaces.

9.6.2 Dimensions and Application

The following striping widths shall be used unless otherwise directed by the City Public Works Department (Table 9-2).

Table 9-2. Striping Widths

Edge Line	6 inches
Skip/Lane Line	6 inches
White Channelizing	8 inches
Bike Lane	6 inches
Double Yellow	5 inches (3-inch gap)
Stop Bar	24 inches (4 feet from crosswalk)
Diagonal Shoulder Marking	4 inches
Yield Line	16-inch-by-24-inch layout based on lane widths, or size to be determined by the City Public Works Department.
Crosswalk Bar[a]	2 feet by 10 feet on Arterials, all others to have a 2-foot-by-8-foot (centered in lane) layout, or size to be determined by the City Public Works Department.

[a] Unless otherwise directed by the City.

Note: Broken or dotted marking patterns shall be in accordance with CDOT specifications.

9.6.3 Surface Preparation

Note: Surface preparation includes cleanup and disposal of removed material.

New concrete pavement shall have all residues removed, such as mud, dirt, and curing compound. Removal shall be by water blasting, sand blasting, or other method approved by the City Public Works Department.

New asphalt pavement shall be dry and free of dirt and debris.

For all restriping on existing concrete or asphalt pavement, the surface shall be clean, dry, and free of debris. Cleaning shall be by water sweeping, water or air blasting, or other method approved by the City Public Works Department. Surface grinding shall be performed where directed by the City Public Works Department.

Surface temperatures shall be 50 degrees Fahrenheit (°F) and rising for all pavement marking applications.

When the surface temperature does not reach 50°F (seasonal), the Contractor may, with the City Public Works Department approval, substitute designated pavement markings with temporary marking materials to be replaced with permanent materials when weather dictates. Temporary pavement markings shall be refurbished as determined by the City Public Works Department.

9.6.4 Installation

All pavement markings shall be applied according to the manufacturer's recommendations, unless otherwise authorized by the City.

The Contractor shall use equipment that meets the following requirements, as approved:

- Equipment shall permit traffic to pass safely within the limits of the roadway.
- Equipment shall be designed for placement of both solid and broken line stripes with a reasonably clean-edged stripe of the width and location as shown on striping plan and no overspray on the road surface.
- Equipment shall have a glass bead dispenser directly behind and synchronized with the paint applicator. Each applicator shall have individual control and automatic skip control that will paint a stripe with a gap as shown in the striping plan.
- The equipment may be equipped with a heat exchanger to heat the paint to reduce drying time.
- The operation shall include a trailing vehicle equipped with a flashing arrow board.

The Contractor shall prevent traffic from crossing a wet stripe. Stripes that have been marred or picked up by traffic before they have dried shall be repaired at the Contractor’s expense. Removal of paint from vehicles that crossed wet paint shall be at the Contractor’s expense.

9.6.5 Pavement Marking Warranty

A 1-year warranty under normal traffic wear is required for pavement marking installations. Material shall not peel or lift in this time period. Approval of all work must be obtained from the City Public Works Department prior to the start of this warranty period.

9.6.6 Use of Stop Bars

The following must include a stop bar:

- Any STOP sign controlled approach to a crosswalk adjacent to a school
- Any multiway, stop-controlled approach
- Any approach to a signalized intersection that does not have a crosswalk.

Stop bars may be staggered longitudinally on a lane-by-lane basis or as determined by the City Public Works Department.

9.6.7 Word or Arrow Pavement Marking

Pavement arrows shall be placed 70 feet upstream of the back of a stop bar or crosswalk on approaches to signalized intersections. For multiple turn arrows in a single lane, number and spacing shall be in accordance with CDOT S Standards. See MUTCD Chapter 3B for all other word or arrow pavement marking placement or as determined by the City.

9.6.8 Bike Lanes

Bike lanes are lanes that have been designated with pavement markings for the preferential use of bicyclists. They are typically one-way facilities located to the right of the general travel lanes on both sides of two-way streets.

9.6.8.1 Bike Lane Width

The minimum bike lane width on a roadway with no curb and gutter is 5 feet. On a roadway with curb and gutter, the minimum width of a bike lane is 5 feet, measured from the face of curb. Exceptions shall be approved by the City on a case-by-case basis.

9.6.8.2 Designating Bike Lanes

Bike lanes shall be designated with the bicycle symbol, which consists of the bike lane rider symbol in combination with the directional arrow (refer to Standard Detail SS-11). The directional arrow encourages bicyclists to ride with traffic, as the law requires.

Bicycle lane markings should be placed after intersections and major driveways (confer with the City Public Works Department for questions about placement). In rural areas, the maximum spacing of bike lane markings should not exceed 1,500 feet. In urban areas, the spacing should not exceed 700 feet or as determined by the City Public Works Department.

9.6.8.3 Bike Lanes at Driveways and Intersections

In Colorado, bicycles are vehicles, so bicyclists are required to follow the rules of the roadway when riding on the streets. Consequently, the striping and marking of bike lanes at intersections should support the operations of bicycles as vehicles and the safe mixing of bicyclists with motorists at conflict points such as driveways and intersections. For both motor vehicles and bicycles, the approach to a right turn and the right turn itself shall be made from as close as practicable to the right-hand curb or edge of the roadway. To support crossing a bike lane to execute a right turn, the bike lane striping transitions to dotted markings on the approach to the intersection. A minimum 50-foot dotted line should be provided, but the length of the dotted line may vary based on the speed of the parallel roadway.

When motorists cross a bike lane to move into a right-turn lane, motorists are required to yield the right-of-way to bicyclists in the bike lane. The BEGIN RIGHT TURN LANE YIELD TO BIKES sign (R4-4) (Standard Detail SS-15) is appropriate when the right turn lane is added to the roadway at the intersection approach. However, in the right-turn drop lane condition (Standard Detail SS-13) the through bicyclists must cross the motorists' path to continue through the intersection. In this case, the bicyclists must yield to the motorist before moving left; therefore, the R4-4 is not appropriate in these conditions.

9.6.8.4 Shared Lanes

A shared lane is a lane of a traveled way that is open to bicycle travel and vehicular use. On local roadways with low volumes and speeds, a shared lane may be all that is needed to comfortably accommodate a bicyclist. Refer to Standard Details SS-17 and SS-18 for proper placement of shared lane markings. Confirm with the City Public Works Department prior to including shared lane markings in a design plan.

9.6.8.5 Buffered Bike Lanes

A buffered bike lane is separated from adjacent through lanes by a striped out buffer area (Standard Detail SS-17). In some locations, it may be desirable to use less than the full width available for a bike lane. The buffer markings consist of two longitudinal white lines and may incorporate an interior diagonal cross hatch or chevron. These transverse markings shall be included when the buffer space is greater than 3 feet in width. The City Public Works Department prefers a 3-foot maximum buffer lane width.

9.6.8.6 Design of Bicycle Signs

If the sign or plaque applies to motorists and bicyclists, then the size of sign shall be as shown for the conventional roads in accordance with Chapter 2 of the MUTCD. The minimum sign and plaque sizes for shared-use paths shall be in accordance with Chapter 9 of the MUTCD and shall be used only for signs and plaques installed specifically for bicycle traffic applications. The minimum sign and plaque sizes for bicycle facilities shall not be used for signs or plaques that are placed in a location that would have any application to other vehicles.

9.6.8.7 City of Castle Pines Signage and Striping Notes for Construction Plans

1) ALL TRAFFIC CONTROL DEVICES SHALL CONFORM TO THE MOST RECENT VERSION OF THE FEDERAL MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), THE "COLORADO SUPPLEMENTAL MUTCD", AND THE "CITY OF CASTLE PINES ROADWAY DESIGN AND CONSTRUCTION STANDARDS". FURTHER SPECIFICATIONS AND ILLUSTRATIONS ARE LOCATED IN THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) "M AND S STANDARDS".
2) A FIELD INSPECTION OF LOCATION AND INSTALLATION OF ALL SIGNS & MARKINGS SHALL BE PERFORMED BY CITY PUBLIC WORKS DEPARTMENT. ALL DISCREPANCIES IDENTIFIED DURING THE FIELD INSPECTION MUST BE CORRECTED BEFORE THE ONE-YEAR WARRANTY PERIOD WILL BEGIN.
3) THE CONTRACTOR INSTALLING SIGNS SHALL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL UNDERGROUND UTILITIES.
4) TYPE III LIGHTED BARRICADES SHALL BE SET AT ENDS OF ROADWAYS WITH AN R11-2 ROAD CLOSED SIGN MOUNTED TO THE RAILS, SEPARATING FINISHED (AND/ OR ACCEPTED) AND UNFINISHED CONSTRUCTION AREAS AND SHALL BE MAINTAINED BY THE CONTRACTOR/ DEVELOPER. A "ROAD CLOSED AHEAD" WARNING SIGN SHALL BE INSTALLED APPROPRIATELY IN ADVANCE OF THE TYPE III BARRICADES.
5) SPECIAL CARE SHALL BE TAKEN IN SIGN LOCATION TO ENSURE AN UNOBSTRUCTED VIEW OF EACH SIGN.
6) WHERE STOP SIGN CONTROL IS APPROPRIATE, 36" STOP SIGNS SHALL BE USED FOR APPROACHES TO ANY ROADWAY THAT IS CLASSIFIED AS A COLLECTOR OR GREATER.
7) A 7-FOOT MINIMUM HEIGHT SHALL BE MAINTAINED FROM BOTTOM OF SIGN PANEL TO THE TOP GRADE OF SIDEWALK (AT TOP GRADE OF PAVEMENT EDGE WHERE NO SIDEWALK EXISTS).
8) DELINEATION OF ROADWAYS WITHOUT CURB AND GUTTER SHALL BE AS SPECIFIED IN THE CDOT "M AND S STANDARDS". SEE STANDARD DETAIL SS-7 FOR RAISED MEDIAN SIGNS AND DELINEATION.
9) SIGNAGE AND STRIPING HAS BEEN DETERMINED BY INFORMATION AVAILABLE AT THE TIME OF REVIEW. PRIOR TO INITIATION OF THE WARRANTY PERIOD, CITY PUBLIC WORKS DEPARTMENT RESERVES THE RIGHT TO REQUIRE MODIFICATIONS TO EXISTING, OR INSTALLATION OF, ADDITIONAL SIGNAGE AND/ OR PAVEMENT MARKING IF IT IS DETERMINED THAT AN UNFORESEEN SAFETY CONDITION WARRANTS SUCH MODIFICATION ACCORDING TO THE MUTCD OR THE CDOT M AND S STANDARDS. ALL SIGNAGE AND STRIPING SHALL BE SUBJECT TO THE REQUIREMENTS OF THE ONE (1) YEAR WARRANTY PERIOD FOR NEW CONSTRUCTION. ADDITIONALLY, ALL PAVEMENT MARKINGS SHALL NOT LIFT OR PEEL DURING THE FIRST YEAR AFTER INSTALLATION.
10) DIAMOND GRADE MATERIAL SHALL BE USED ON ALL STOP SIGNS AND OVERHEAD SIGNS. ALL OTHER ROADSIDE TRAFFIC CONTROL DEVICES SHALL BE HIGH INTENSITY PRISMATIC RETROREFLECTIVE.

11) ALL PUBLIC ROAD STREET NAME SIGNS SHALL HAVE CITY OF CASTLE PINES LOGO ON LEFT SIDE OF SIGN.

12) ALL REMOVED SIGNS SHALL BE RETURNED TO CITY PUBLIC WORKS DEPARTMENT IF REQUESTED. CALL THE CITY FOR DROP OFF LOCATION.

13) M. CROSSWALKS SHALL:

a) BE CONSTRUCTED OF MATERIAL SPECIFIED BY CITY PUBLIC WORKS DEPARTMENT.

b) BE LONGITUDINAL TYPE.

c) BE CENTERED ON ADA CURB RAMPS.

d) BE CENTERED ON LANE LINES SO AS TO BE STRADDLED BY VEHICLES.

14) ALL PAVEMENT MARKING MATERIAL (INCLUDING WORDS AND SYMBOLS) SHALL BE AS FOLLOWS:

Marking Type/ Surface Type	Edge, Lane, and Channelizing Lines	Crosswalk Bars and Stop Bars	Turn Arrows and Written Legends
Concrete Pavement	Modified Epoxy	Preformed Plastic[a] or Preformed Thermoplastic	Preformed Plastic or Preformed Thermoplastic
Asphalt Pavement	Modified Epoxy	Preformed Plastic or Preformed Thermoplastic	Preformed Plastic or Preformed Thermoplastic

[a] Crosswalk bars shall be recessed.

Note:

Preformed Plastic minimum thickness is 60 mils for legends and symbols, 75 mil minimum for stop bars and crosswalk bars.

Preformed thermoplastic may be used for spot repair or replacement of all marking types on asphalt surfaces.

15) SAND OR WATER BLAST CURING COMPOUND PRIOR TO INSTALLATION OF MARKINGS.

16) INSPECTION AND APPROVAL OF STRIPING AND CROSSWALK LAYOUT TO BE DONE BY CITY OF CASTLE PINES ENGINEERING INSPECTION DEPARTMENT PRIOR TO APPLICATION OF FINAL STRIPING.

9.7 Castle Pines Traffic Signal Specifications

City of Castle Pines will enforce the following requirements for all Traffic Signal Construction Projects and roadway construction projects requiring traffic signal modifications or installations.

1) International Municipal Signal Association (IMSA) Level II Traffic Signal Bench Technician/ Signal Technician certification (BB certification) for any work within the traffic signal cabinet. This includes corrective maintenance and signal turn-on. Signal Contractor shall produce copies of certificates at the preconstruction meeting.

2) IMSA Level II Traffic Signal Field Technician/ Electrician (BE certification) or Traffic Signal Bench Technician/ Signal Technician Certification (BB Certification) for any work external to the traffic signal cabinet. An IMSA Level II Traffic Signal Electrician (minimum BE certification) must be on the jobsite at all times to supervise construction. Signal Contractor shall produce copies of certificates at the pre-construction meeting.

3) The United States Department of Labor – Bureau of Apprenticeship and Training can be substituted for the IMSA Level II Traffic Signal Electrician. Signal Contractor shall produce copies of certificates at the preconstruction meeting.

9.7.1 Scope and Intent

These specifications describe the installation of necessary material, equipment, and work procedures to complete traffic signals, or other electrical systems as shown on the drawings, in the special contract provisions, or herein, for projects in the City of Castle Pines, Colorado. These specifications provide minimum functional requirements that must be satisfied for all such work.

9.7.2 Roadway Work and Permits

Unless stated otherwise, all roadway and sidewalk work shall be in accordance with the latest version of the City of Castle Pines Roadway Design and Construction Standards. For all work, the Contractor shall obtain Permits from the City Public Works Department (on the City website) and shall pay the required City construction Permit fees.

9.7.3 City Engineer Representative

City of Castle Pines Project Engineer or authorized City personnel shall be the responsible person overseeing all work on the City's behalf. For all required inspections, the Contractor shall give at least 48 hours' prior notice to the City Public Works Department.

9.7.4 Private Access and Traffic Control Plan

The Contractor will be required to maintain access to all private drives throughout the period of construction. The Contractor shall be required to erect, maintain, and remove all barricades, traffic control signs, and devices. Such barricades and traffic control signs and devices shall be in accordance with the latest version of the MUTCD published by the U.S. Department of Transportation, Federal Highway Administration, and as directed by the Engineer. Construction signs not applicable during nonconstruction times shall be set so traffic cannot see the signs, in accordance with section 630 of the latest edition of the CDOT Standard Specifications for Road and Bridge Construction. Should this not occur, Section 9.13.4d of this document shall be enforced.

A Traffic Control Plan prepared by a certified traffic control supervisor shall be submitted and approved prior to issuance of the Permit by the City Public Works Department. The Traffic Control plan shall be submitted along with a set of construction drawings signed and approved by the City. The Contractor shall submit the plan at least 5 working days in advance of the intended start date. A City-approved copy shall be kept at the site and shall be exhibited upon request to any authorized City representative. The City reserves the right to require the Contractor to modify the traffic control in the field as necessary. The City also reserves the right to issue a stop-work order. Permitting information can be found on the City's website.

9.7.5 Testing

The City may, at its option and cost, retain the services of an independent testing lab to perform all testing consultation and to assist in the review of the work and equipment.

Refer to Section 9.14.18 for requirements regarding early delivery of controller and cabinet to the City for testing purposes.

9.7.6 Equipment Salvage

All traffic signal equipment that is removed shall remain City property. Such property is to be removed from the work site, tagged with date removed and location, and returned by the Contractor to the City if

requested. When signal pole and mast arm assemblies are removed, all components shall be marked as a set with permanent markings. The equipment shall be returned in the same condition as prior to removal. Contact the City Public Works Department to coordinate delivery.

9.7.7 Existing Traffic Signals

When existing traffic signal installations are modified or completely rebuilt, the Contractor shall work around existing traffic signal equipment until the new or modified traffic signal system has been installed and put into operation. Signal heads installed on mast arms or poles for new installation that are not ready for actual electrical operation shall be bagged with orange plastic. The Contractor shall at all times maintain a minimum of two three-section (red, yellow, and green) traffic signal heads and pedestrian heads (if required) for each roadway approach. These displays and all other signal elements shall conform to MUTCD. Special consideration shall be made to avoid the left-turn trap situation.

9.7.8 Intersection Power

Unless otherwise directed in the plans, the Contractor shall be responsible for coordinating with the power company to obtain power hook-up to the intersection and luminaires 2 weeks prior to signal flash. Refer to Section 9.14.41. The City's Building Division will inspect all installations prior to meter installation.

9.7.9 Utilities

Utilities are shown on the plans to the extent that they can be, based on records and surface field indications. All utility locations will require field verification in cooperation with the affected utility companies and public agencies. The Contractor shall be responsible for locating all valve boxes, maintenance holes, and the like, and confirming that they are properly protected and that signal equipment locations are adjusted accordingly, with approval from the City Public Works Department. The Contractor is also responsible for filling all holes made by vacuum potholing (required utility locates) with appropriate material (concrete, asphalt, or other fill to match existing) to restore the area back to previous condition.

9.7.10 Work Hours

The Contractor shall work only on weekdays between the hours of 7:00 a.m. to 4:00 p.m. Lane closures shall only be allowed between 8:30 a.m. and 3:00 p.m. The Contractor must receive written approval from the City to work at any other time.

9.7.11 Project Schedule

The following schedule shall apply (Table 9-3):

Table 9-3. Project Schedule

Item	Schedule
Pole Foundation installation	Refer to 9.14.44.3
Shop Drawing Submittals	At the preconstruction meeting, which normally will be about 2 to 3 weeks prior to the Notice to Proceed.
Groundwork (conduit, mast arm pole foundations, etc.)	May start up to 30 calendar days after Notice to Proceed but no less than 30 calendar days prior to essential equipment delivery date.
100% Completion	Prior to signal flash

Overall Project	90 calendar days for mast arm project; 60 calendar days for span wire project.

9.7.12 Failure to Complete Work on Time

A daily charge, in the applicable amount set forth in the schedule of liquidated damages below, will be made against the Contractor for each calendar day that any work remains uncompleted after the expiration of contract time. This daily charge will be deducted from any money due the Contractor. This deduction is not a penalty but is liquidated damages.

The schedule of liquidated damages set forth in Table 9-4 is the amount agreed to by the Contractor and the City as reasonably representing additional construction engineering costs incurred by the City if the Contractor fails to complete performance within the contract time.

Table 9-4. Schedule of Liquidated Damages

Original Contract Amount		
From More Than ($)	To and Including ($)	Daily Charge ($)
0	25,000	270
25,000	50,000	465
50,000	100,000	540
100,000	500,000	950
500,000	1,000,000	1,250

Due account shall be taken of any adjustment of the contract time for completion of the work granted by the City at the City's discretion, as a result of supplier delays beyond the Contractors' control. The Contractor shall provide written documentation of such delays to the City's satisfaction.

Permitting the Contractor to continue and finish the work or any part thereof after expiration of contract time will not operate as a waiver on the part of the City of any of its rights under the contract.

Any deduction assessed as liquidated damages for delay under this subsection shall not relieve the Contractor from liability for any damages or costs resulting from delays to other contractors on the project or other projects caused by a failure of the assessed Contractor to complete the work according to contract times.

9.7.13 Job Site Conditions

The Contractor shall maintain a safe and clean job site throughout construction. Upon project completion, the job site shall be neat and clean with all trash and dirt picked up and barricades removed. Landscaping shall be restored, sidewalks swept, and utility locate markings removed. The intent is that the job site appears as good or better than it appeared before construction.

9.8 Regulations and Codes

9.8.1 Reference Documents

All equipment, material, and construction methods shall conform to the standards of the ITE, IMSA, and CDOT Standard specifications for Road and Bridge Construction (latest edition), unless noted otherwise. In addition to the requirements of these specifications, the plans, standard details, and the special contract

provisions, all material and work shall conform to the requirements of the MUTCD, National Electrical Code (NEC), NESC, the Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission (Rules), ASTM Standards, the American National Standards Institute, and local ordinances that may apply.

Wherever reference is made in these specifications or in the special contract provisions to the MUTCD, NEC, NESC, Rules, or the standards mentioned previously, the reference shall be construed to mean the document that is in effect at the date of bidding.

9.9 Equipment List, Approvals, and As-Built Drawings

9.9.1 Bid Requirements

Shop drawings are not required for the bid, but the Contractor shall submit with its bid a list of equipment and materials that it proposes to furnish for those items listed in Section 9.8.1, including all equipment and materials as identified on the plans or in the specifications, by the manufacturer's name that is necessary or customary in the trade to identify such equipment and material. The list shall be complete as to the name of manufacturer, unit name, and model number.

Items to which Section 9.8.1 applies include, but are not limited to, the following: traffic signal poles and mast arms, pedestrian push buttons, traffic signal controller and cabinet, uninterruptable power sources (UPS), vehicle detection, vehicle and pedestrian signal heads, pedestrian signs, pre-emption devices, mounting hardware for signal heads, street name signs, pull boxes, wire, communication equipment, fiber or radio (fiber-optic cable shall include interconnect schematic diagram), point-tilt-zoom cameras, travel time equipment, meter disconnect pedestal, and any additional items indicated in the project special provisions or requested at the preconstruction meeting. Sign panel layouts for both illuminated and aluminum street name signs shall also be submitted for City approval.

9.9.2 Sampling and Substitutions

Inspection or sampling of any materials, other than those already approved, must be made by the City prior to installation. Whenever particular material or equipment is identified by manufacturer name in the plans or specifications, the term "or approved equivalent" is implied. If the Contractor proposes a substitution, the Contractor shall provide additional information with the bid to prove the substitution item is of equal or superior quality, and it shall be at the City's sole discretion whether to approve such substitution. If not approved, Contractor shall agree to supply the originally stated material or equipment at no additional cost. Otherwise, the City may reject the bid as nonresponsive.

The Contractor shall attach to the bid a statement that all material to be supplied is either in exact accordance with the specifications or shall list in detail any and all substitutions and request the approval of the City for the substitutions. The City may request further technical information to support the substitution.

During execution of the work, the supplying of equipment that is not in accordance with the specifications and on which the Contractor has not received the City's approval shall be cause for rejection. Correction of the non-specification items will be entirely at the Contractor's expense.

9.9.3 As-Builts

Upon completion of the work, the Contractor shall submit an "as-built" or corrected plan showing, in detail, all construction changes, including, but not limited to, wiring, cable, poles, controller cabinet,

vehicle detection, and location of all conduit. Red lined, signed, stamped plans may be submitted as "as-built" plans.

9.10 Excavating and Backfilling

9.10.1 General

Street cuts for conduit on existing pavements shall not be allowed unless included in Right-of-Way Permit. Excavations for the installation of conduit, foundations, and other equipment shall be performed in such a manner as to cause the least possible damage to the streets, sidewalks, and other improvements or landscape and sprinklers. Trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances, and foundations and shall be kept clean and as free of moisture as possible. Excavations shall be backfilled or poured with Flow Fill within 24 hours of opening, unless otherwise approved in writing by the City Public Works Department. The material from the excavation shall be removed as the trenching progresses.

After backfilling, excavations shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

Excavating and backfilling for foundations shall be incidental to the pay item for which a foundation is required. Excavating and backfilling for conduit trenches shall be paid for under the appropriate conduit trenching pay item.

At the preconstruction meeting, the Contractor will be provided contacts for landscape and sprinkler repair. The Contractor is responsible for contacting these entities when damage occurs and coordinating repairs. Any necessary repairs will not be paid for separately but shall be included in the project cost. Damages found subsequent to project completion, and related costs, will be the Contractor's responsibility.

9.10.2 Traffic Maintenance

At the end of each day's work and any other time construction operations are suspended, all construction equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic. Construction signs not applicable during nonconstruction times shall be set so traffic cannot see the signs, in accordance with section 630 of the latest version of the CDOT Standard Specifications for Road and Bridge Construction. Should this not occur, Section 9.13.4 of this document shall be enforced.

Excavations in streets or highways shall be performed in such a manner that at least one lane of traffic in each direction shall be open to public traffic at all times. All lane closures shall be approved by the City prior to closure.

When excavations must remain open overnight, they shall be properly marked to warn motorists and pedestrians according to the MUTCD. Flashing barricades shall be provided unless otherwise authorized in writing by the City.

9.11 Removing, Replacing, and Resetting Improvements

9.11.1 General

The Contractor shall, at its sole expense, replace or reconstruct sidewalks, curbs, gutters, rigid or flexible pavement, and any other improvements removed, broken, or damaged by it with material and methods that conform to current City standards.

Whenever a part of a square or slab of existing concrete, sidewalk, or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as specified in the previous paragraph.

Concrete pavement and sidewalk designated for removal shall be removed as marked by the City or its designee. The concrete pavement or sidewalk shall be cut to the existing depth of concrete prior to removal. Any overbreak, separation, or other damage to the existing concrete outside of the designated removal limits shall be replaced at the Contractor's expense. Payment for removal of concrete pavement or sidewalk shall be based on square yards of surface area regardless of the concrete thickness.

Removal items shall be as indicated in the pay item list or items specifically identified on the plans, or in writing by the City. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included removal items prior to bidding.

Reset pay items shall be as indicated in the pay item list. These items are to be initially removed, then adjusted or modified as directed by the City, and finally reinstalled to full operational capability. Modifications and adjustments shall be detailed on the plans or project special provisions and shall be incidental to the reset pay item. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included reset items prior to bidding.

The "Reset Traffic Signal Equipment" pay item list shall consist of the items specifically identified in the plans or in the project special provisions. Reset traffic signal equipment typically shall include the traffic signal poles, arms, controllers, cabinets, signal and pedestrian heads, detectors, coordination and interconnect equipment, and all other related equipment and materials necessary to remove the items from their existing location and reset them at the new location. This shall include all mounting hardware, bases, other electrical equipment and service, including temporary power, and all other materials and work necessary to complete the reset item in service at the new location. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included reset traffic signal equipment items prior to bidding.

Equipment and materials shall be cleaned and touched up prior to reset. This work shall be included in the cost of "Reset Traffic Signal Equipment."

9.12 Underground Facilities

9.12.1 Drilled Caissons and Foundations

All drilled caissons and foundations shall be Portland cement concrete conforming to the applicable requirements of the City's construction standards, except as herein provided.

The bottom of concrete drilled caissons and foundations shall rest on firm ground. Cast-in-place foundations shall be poured monolithically where practicable. The exposed portions shall be formed to present a neat appearance. Concrete shall be Class BZ in accordance with the latest edition of the CDOT's Standard Specifications for Road and Bridge Construction.

All poles shall be grounded as indicated in the standard details and shall be incidental to the installation pay item.

For drilled caissons requiring casing, casings shall be removed in a manner such that voids between the excavation and the casing will be completely filled with fresh concrete.

Anchor bolts shall conform to the manufacturer's specifications, and each individual bolt shall have two flat washers and two nuts. Shims or other similar devices for plumbing or raking will not be permitted. Stirrups shall be installed on all caissons. See City of Castle Pines Standard Signal Details for additional requirements.

All caissons will be measured and paid for separately.

Forms shall be true to line and grade. Tops of caissons and foundations, except as noted on plans, shall be finished to curb or sidewalk grade or as ordered by the City. Forms shall be rigid and securely braced in place and inspected prior to the concrete pour. Conduit ends and anchor bolts shall be placed in proper position and in a template until the concrete sets.

Both forms and ground that will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Whenever excavation for a foundation requires removal of excess ground materials, the excavation shall be backfilled to within 12 inches of ground level with 60 to 120 pounds per square inch (psi) of Flow Fill as specified by the City, and then backfilled to ground level with compacted native material.

Any abandoned caisson or foundation shall be fully or partially removed and disposed of by the Contractor according to the City's direction. Any conduit runs associated with an abandoned caisson or foundation shall be extended or abandoned as called for on the plans.

The Contractor is responsible for filling all holes made by vacuum potholing, in regards to locating utilities for caisson placement, with appropriate material or replacing curb, sidewalk or roadway panels, or stones as specified in City of Castle Pines Roadway Design and Construction Standards to restore these back to previous condition.

9.12.2 Conduit

All intersections undergoing initial development or construction that are anticipated to require immediate or short-term future signalization shall include signal conduit at the time of initial road construction, in conformance with this section. Those intersections not completely built out or anticipated to be signalized within a year's timeframe, shall have construction funds escrowed for construction costs at a later date. Roadway developers should consult with the City to identify intersections to which this requirement applies.

Pull boxes made of fiberglass reinforced polymer concrete (refer to Section 9.12.3) shall be used at termination points, as shown in the standard details.

All cables and conductors not shown on the plans as aerial cable shall be installed in conduit unless installed in poles, pedestals, or mast arms. All metal conduit referred to in the specifications and shown on the plans shall be the rigid pipe type of ductile steel that is adequately galvanized. All polyvinyl chloride (PVC) conduit shall be Schedule 80 or heavier. Poly pipe commonly used for boring shall be Schedule 80 or heavier. All transitions from poly pipe to PVC shall be by means of Etco "E-LOC" couplings or approved equal.

New conduit runs shown on the plans are for bidding purposes only and may be changed at the City's direction.

All conduit installed, including poly pipe, shall be at full depth (minimum 30 inches below finish grade) for the entire conduit run. Sweeps of 90 degrees shall not be cut to achieve proper entrance to pull box. Conduit runs shall have no more than a 180 degree bend.

Conduit shall always enter a pedestal base, pull box, or any other type of structure from the direction of the run only. Conduit connections at junction boxes shall be tightly secured.

Conduit under railroad tracks shall be at the minimum depth below the bottom of the tie required by the particular railroad company.

The following conduit schedule is in effect unless otherwise specified in the plans (Table 9-5):

Table 9-5. Conduit Schedule

Run Type	Quantity	Size (inches)	Use
Street Crossings	2	3	High-voltage load wiring
	1	2	Low-voltage detection and communications
	1	2	luminaire load
Signal Pole	2	3	High voltage
	1	2	Low voltage
Pedestal Pole	1	3	High voltage
	1	2	Low voltage
Controller Cabinet	2	3	High-voltage load wiring
	2	2	Low-voltage detection – size per Code
	1	2	Service power
	1	2	Interconnect
Interconnect	1	2	Interconnect run only
Service Points Signal	1	2	Utility company service run for traffic signal

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or blown out with compressed air.

All conduit in pull boxes shall extend a minimum of 3 inches above crushed rock.

All conduit shall terminate in pull boxes such that when cable is pulled and coiled within the pull box, there is a minimum clearance of 3 inches between the pull box lid and the conduit and cable. Cable and conduit shall not be crushed or damaged.

Conduit terminating in a standard power pedestal, signal pole, or pedestal pole base shall extend a minimum of 3 inches above foundation vertically.

All underground interconnect conduit runs shall have a single number (No.) 14 AWG (American Wire Gauge) (minimum), fully annealed, solid conductor tracer wire with an orange sheath or jacket, installed for locating purposes.

Field cuts of existing or new conduit shall be made square and true, and the ends shall butt together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling metal conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. All couplings shall be screwed tight until the ends of the metal conduits are brought together. The ends of all metal conduit, existing or new, shall be well reamed to remove burrs and rough edges.

Where a "stub out" is called for on the plans, a minimum 18-inch radius sweeping elbow shall be installed in the direction indicated and sealed with a metallic cap to facilitate future locating. The locations of ends of all conduits in structures or terminating at curbs shall be marked by a "Y" at least 3 inches high, cut into the face of the curb, gutter, or wall directly above the conduit.

Where factory bends are not used, conduit shall be bent without crimping or flattening, using the longest radius practicable. Conduit bends feeding pull boxes and foundations shall be as shown on the standard details, typically 18 inches.

All conduit runs that exceed 10 feet in length shall have at a minimum a continuous half-inch, 1,250-pound pull strength, flat-woven polyester tape (Muletape, BullLine, or equivalent) pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with a minimum slack of 4 feet. The purpose of this rope is to be able to pull future electrical cable through the existing conduit runs and the rope shall not be tangled or twisted around cables.

Any spare or unused conduits installed for future use shall be sealed with a metallic cap and a single No. 14 AWG (minimum), fully annealed, solid conductor tracer wire installed for locating purposes. Conduit shall also have at a minimum a continuous half-inch, 1,250-pound pull strength, flat-woven polyester tape (Muletape, BullLine, or equivalent) pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with a minimum slack of 4 feet.

Split duct may be allowed on a case-by-case basis approved by the City.

9.12.3 Pull Boxes

A pull box shall be installed at all locations as shown on the plans and at such additional points as ordered by the City. Pull boxes shall be installed at intervals of every 500 feet or as specified in the plans for all fiber interconnect conduit runs. Pull boxes shall be fiberglass reinforced polymer pre-cast concrete with a minimum Tier 15 rating (See Standard Details).

The Contractor shall install City-provided delineators at all pull box locations. The delineators shall be anchored into the ground with minimum quarter-inch-diameter bolt, minimum 2 inches in length so they cannot be easily pulled out of the ground. Refer to recommendation in standard notes.

At new roadway construction sites where conduit for future traffic signals is installed, pull boxes shall be installed at conduit termination points and single 14 AWG (minimum), fully annealed, solid conductor tracer wire installed through the entire conduit run to facilitate future locating.

At sites where operational traffic signals are being installed, permanent fiberglass reinforced polymer concrete precast pull boxes shall be installed (refer to standard details).

Pull boxes shall be installed so that the covers are level, as well as flush with curb or sidewalk grade or level with the surrounding ground when no grade is established. The entire excavation required to install 90 degree sweeps into a future pull box shall be backfilled from the full depth of the conduit run to the

bottom of the pull box with crushed rock. The depth of crushed rock from the bottom of the excavation to the bottom of the pull box shall be a minimum of 18 inches.

The interior of the pull box shall be backfilled with crushed rock from the base of the pull box to a minimum depth of 3 inches below the top of conduit runs. The area of the excavation surrounding the pull box may be backfilled with excavated soil.

When a new conduit run enters an existing pull box, the Contractor shall temporarily remove the pull box, or tunnel under the side at no less than 18 inches below the pull box bottom and enter from the direction of the run. Backfill shall be gravel. No new conduit will be allowed to enter a new or existing pull box in any other manner than that shown on the standard details.

9.12.4 Loop and Micro Loop Detectors

Each individual loop or micro loop is to be terminated and spliced within a side-of-road pull box as specified on the standard details. Each loop shall consist of one continuous wire, without splicing, to this termination point, and each micro loop detector shall include two continuous wires, without splicing, to this termination point. Each loop or micro loop shall have its own dedicated lead-in pair (of wires) to the cabinet from the side of road pull box. Detector lead-in wire shall be continuous from the controller to the side-of-road pull box.

All detectors shall have a color-coded tag attached to the lead-in to indicate the relative location and the direction served by the detector. Refer to Section 9.13.1.

Loop sealant is to be used in all saw cuts whether or not the roadway is to be overlaid. Refer to standard details.

Stop line detection for designated phases shall be provided, as indicated in the plans. Advance detection may be provided on a stie-specific basis, to extend green time on high-speed approaches.

The use of preformed loop detectors shall not be allowed.

9.13 Conductor and Cable

9.13.1 General

Wiring shall conform to appropriate NEC articles. Wiring within cabinets, junction boxes, and the like shall be landed and labeled as shown in the specifications and details as well as neatly arranged.

Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit. Unless otherwise approved by the City, wiring shall not occupy more than 40% of the inside area of all conduit. If more than 40% of the inside area is occupied, the Contractor shall provide additional conduit to satisfy this requirement.

Half-inch, 1,250-pound pull strength, flat-woven polyester tape (Muletape, BullLine, or equivalent) shall be installed in new conduit and in existing conduit where a cable is added or an existing cable is replaced. A minimum of 4 feet of slack shall be left in each conduit at each termination.

At least 5 feet of slack shall be left for each conductor at each span wire support pole.

Except in accordance with Section 9.12.4, splices will not be allowed in pull boxes. Splices shall be kept to a minimum and will only be allowed in hand holes at pole bases. A minimum of 24 inches of slack shall be left on each splice wire. In no case shall any shellac compounds be used.

Signal load splices shall use a copper crimp sleeve connector that is compressed from four directions, for example, as manufactured by the Buchanan Company. All hand hole splices shall be compressed by a C-24 four-way pres-SURE-tool, such as produced by the Buchanan Company. The crimped sleeve shall then be protected within a flexible rubber insulating cover; for example, an Ideal Wrap Cap. All splices or splice bundles shall face upward in the hand hole compartment.

Detector loop lead-in splices in pull boxes (refer to Section 9.12.4) shall be fully waterproofed using a splice kit or epoxy wire nuts (Buchanon BTS2 or BTS4 or approved equal). A minimum of 12 inches of slack shall be left on the detector loop.

When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped and marked.

All high-voltage home run signal wiring shall use IMSA spec 19-1, 25 conductor cable, continuous from the cabinet to the base of each pole or hand hole. Conductor cable shall be installed where required in the plans. Overhead cable shall be secured to messenger cable with cable rings or stainless steel wire wrap only.

All signal cables terminating at the cabinet shall contain a small permanent tag identifying phase and direction. All signal cables shall be phase taped in the cabinet and at each hand hole using the codes given in the "Conductor Schedule" in the following paragraph. Loop detector lead-ins shall be tagged in the splice pull box behind curb.

Conductor Schedule Key-Phase: Color of Signal Load Conductor "Code" (on tag at each end of conductor):

1) Northbound Left Turn: Red/ White, "x-NBLT"
2) Northbound: Red, "x-NB"
3) Southbound Left Turn: Green/ White, "x-SBLT"
4) Southbound: Green, "x-SB"
5) Eastbound Left Turn: Orange/ White, "x-EBLT"
6) Eastbound: Orange, "x-EB"
7) Westbound Left Turn: Blue/ White, "x-WBLT"
8) Westbound: Blue, "x-WB"
9) Pedestrian: Yellow, "x-PED"
10) Supplemental: Brown, Right turn overlap
11) Supplemental: Purple, spare

NOTE: x = phase number. This is a typical conductor identification schedule and shall be used for the wiring of all signal installations. An individual conductor wire schedule is in the standard signal details. Deviations from these standards will be noted on the plans at each intersection where different phasing or special equipment is required. It should be noted that a band of white is used to indicate a left turn, a band of brown is used for a right turn, and a band of yellow is used for a pedestrian movement.

Each pedestrian push button shall have a dedicated wire pair lead-in to the controller cabinet.

Separate luminaire wire shall be a 12/2 conductor, plus ground and UL listed.

Signal heads mounted on mast arms or poles shall be wired individually with IMSA spec 19-1, 7-conductor cable from the head to the hand hole at the bottom of the pole.

Span wire and tether cable shall be affixed to the pole using short bail strand vices. If required by the City, insulators shall be provided, in which case, long bail strand vices shall be used.

9.13.2 Bonding and Grounding

Metal poles, pedestals, and cabinets shall be made mechanically and electrically secure to form a system of isolated grounded components. Each pole and pedestal shall have a separate ground rod, located in an adjacent pull box and connected to the system component. The controller cabinet shall have a ground rod located in its foundation. Separate ground rod locations shall not be directly connected to one another with ground wire, in order to minimize transient distribution among the components.

Bonding and grounding jumpers shall be copper wire, No. 8 AWG, for all systems. Loop lead-in drain wire is to be grounded in the control cabinet only. The other end of the sheath is to be taped and left ungrounded.

Bonding of poles and pedestals shall be by means of connecting to the ground rod, a bonding strap attached to an anchor bolt or a 3/16-inch diameter or larger brass or bronze bolt installed in the lower portion of the shaft.

At each grounded pull box, the ground electrode shall be a one-piece copper ground rod driven into the ground so that the top is at least 2 to 4 inches below the bottom of the pull box lid. The ground rod connector shall be placed so that the bare copper wire, No. 8, can be pulled into a pole, pedestal, or attached to the control cabinet ground bus.

Loop lead-in drain wire is to be grounded in the control cabinet only. The other end of the sheath shall be taped and left ungrounded. All poles shall be bonded to the signal power source.

9.13.3 Field Testing and Maintenance

9.13.3.1 Field Testing

- Prior to completion of the work, the Contractor shall run the following tests on all traffic signals in the presence of the City or the City signal maintenance contractor.
- Each circuit shall be tested for continuity and for grounds.
- A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended herein. The functional test for each traffic signal system shall consist of not less than 20 days of continuous, satisfactory operation commencing with full operation of all electrical facilities.
- For all fiber-optic cable testing requirements, refer to Section 9.14.23.

9.13.3.2 Maintenance during Construction

- The Contractor shall have full maintenance responsibility of the traffic signal from the time of the Notice to Proceed to substantial completion. Continuous maintenance and emergency service shall be provided by the Contractor 24 hours each day during the time period defined previously. The

Contractor shall provide and maintain a 24-hour continuous telephone answering service with one number with a response time of 2 hours or less. Should this not occur, Section 9.13.4d of this document shall be invoked.

- If the Contractor must close lanes or otherwise shift traffic for construction purposes, the Contractor shall have full responsibility of bagging existing or new signal indications or traffic control signs as directed by the City for the impacted approach for the duration of each phase of work impacting that approach. Should this not occur, Section 9.13.4d of this document shall be invoked.

9.13.4 Emergency and Non-emergency Repairs

During the 2-year warranty period, all hazardous conditions or all malfunctions of a controller and its accessory equipment following turn on shall be considered an emergency unless otherwise identified by the City. Site conditions, equipment malfunctions, or damage, which in the opinion of the City constitute a serious hazard or inconvenience to the public, shall be considered an emergency. Such malfunctions or damage may include, but not necessarily be limited to, the following situations:

1) All indications are out, including bulbs and lenses, for any one traffic movement.
2) Signal heads give conflicting indications to any intersection approach or approaches.
3) Any signal head or sign becomes loose and or twisted.
4) Any accessory equipment malfunction.
    a) Contractor shall dispatch personnel to undertake each such repair no later than 1 hour after the City notifies Contractor of the emergency.
    b) Personnel responding shall arrive within 1 hour after notification during regular City working hours and within 2 hours during non-working hours after notification.
    c) In instances of repairs that are of a non-emergency nature and determined to be the Contractor's responsibility by the City, such repairs shall be undertaken at the site within 1 working day after the City notifies the Contractor of the needed repair.
    d) Should the Contractor fail to perform any maintenance responsibilities within the prescribed time periods, the City shall employ the services of the City's traffic signal maintenance contractor to perform said maintenance work. The Contractor shall reimburse the City for labor and equipment charges plus 15% for administration associated with the use of the City's traffic signal maintenance. Labor, materials and 10% will be subtracted from the total contract amount.

9.14 Traffic Signal Material Specifications

9.14.1 Vehicle Signal Head

All vehicle signal heads shall be the modular section type and shall be adjustable with respect to positioning and lens replacement. Heads shall be polycarbonate and black in color and shall meet the requirements of the latest version of the ITE standard, "Vehicle Traffic Control Signal Heads." Unless otherwise indicated, traffic signal faces shall be light-emitting diodes (LED). Refer to Section 9.14.6 for LED requirements.

Visors shall be the detachable tunnel type and black in color.

All mast-arm-mounted vehicle signal heads shall be equipped with louvered aluminum backplates, black in color, with 2-inch diamond-grade fluorescent-yellow retroreflective border.

Doors on the signal heads for the installation of lamps and lens replacement or other maintenance shall not require use of any tool whatsoever to open. Doors and lenses shall be equipped with neoprene weatherproof gaskets to protect against infiltration of moisture, road film, and dust. Each signal indication shall have leads from all signal sections connected to a terminal board stamped with identifiable terminals. There shall be a terminal for color indication plus a common terminal where one lead from each LED indication shall terminate. The terminal board shall be mounted in the middle section and be fully insulated. Gaskets shall be supplied for top and bottom openings.

Traffic signal heads shall be attached using standard ASTRO-BRAC Assembly or approved equivalent. Side-of-pole signal heads shall be installed with banding blocks and 90 degree elbows with nipple length determined by the size of the head so as not to interfere with closing doors.

9.14.2 Pedestrian Signal Head

Pedestrian signal heads shall be 16-inch, clamshell type, McCain or approved equal, and shall be adjustable with respect to positioning. Heads shall be polycarbonate, black in color, and shall meet the requirements of the latest version of the ITE standard, "Pedestrian Traffic Control Signal Indications." Countdown pedestrian indications shall be the symbol type with a minimum height of 11 inches. Countdown pedestrian indications shall be LED indications. Countdown numerals shall have a minimum height of 9 inches. Doors and lenses shall be installed with weatherproof gaskets to protect against infiltration of moisture, road film and dust. Visors shall be eggcrate type.

9.14.3 Countdown Pedestrian Signal Head

There should be two message overlays, combining Portland Orange LED for the “Hand” and White LED for “Walking Person.” LED should be incandescent style. The double-digit display for countdown should be made of Red LEDs; LED should be incandescent style.

Timing is derived directly from the controller and no timing shall be programmed, or otherwise initiated. Countdown numerals shall be illuminated continuously during countdown and not alternating. Pedestrian signal head shall blank out countdown portion if the countdown is different from the controller.

Hand and Walking Person indications shall be LED.

9.14.4 Blank-Out Regulatory/Warning Sign

9.14.4.1 General Description

- LED Blank-Out Signs are designed to display single or multiple messages. The messages shall be clear and legible, under any lighting conditions. When not energized, the sign shall be completely dark without any ghost images. LED blank-out signs shall comply with applicable MUTCD and ITE specifications on LED signals.
- Illumination of the messages shall be provided by an assembly of LEDs. LEDs shall be wired to incorporate fault tolerance or bypass to isolate LED failures – failure of one LED string shall not cause the failure of any other LED strings.
- When energized, the messages shall provide a minimum 30 degree viewing angle centered about the optical axis.

9.14.4.2 Housing

- LED Blank-Out Sign housing shall be an aluminum alloy that is moisture proof and mechanical vibration protected.

- Housing shall have neoprene gaskets installed between sign panels and fixture housing to prevent water entry. Screened weep holes shall be provided on housing bottom for drainage.
- Housing shall be mounted with Astrotype mounting brackets.
- Sign fixture and panels shall withstand 90 mph wind loading, with structural requirements meeting the latest edition of AASHTO's "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals."

9.14.5 Illuminated Street Name Sign (LED)

All street signs shall be consistent in nature with the existing signs. At the City's discretion, the sign design may be changed.

When indicated on the plans, illuminated street name signs (LED) shall be used, conforming to the following requirements:

- **Mechanical Specifications**. Illuminated street name sign housings shall be constructed of 5052 aluminum alloy with a minimum one-eighth-inch thickness. All hardware parts shall be stainless steel. The outer dimensions of the sign assembly (excluding the mounting bosses) shall be standard widths of 15 to 30 inches (in 3-inch increments), and standard lengths of 4 to 10 feet in1-foot increments, unless otherwise approved. The maximum thickness of the sign shall be 3.95 inches for single-sided signs, and 5.4 inches for double-sided signs. The overall weight, excluding mounting hardware, shall not exceed 6 pounds per square foot (psf) for single sided signs, and 8 psf for double-sided signs. Signs shall be mounted either free swinging or rigid on approved Pelco or equivalent mounts. No tools shall be required to open the sign. Finish shall be polyester powder coated to required color specification. The signal panel shall rotate open with a bottom hinge.
- **Sign Panel and Sheeting**. The sign panel shall be polycarbonate, white with an eighth of an inch minimum thickness. Sign sheeting shall be 3M 4000DG3 series reflective sheeting or equivalent. The sign colors shall not fade when exposed to an accelerated test of ultraviolet light equivalent to 5 years of outdoor exposure. The Electrocut film shall be 3M 1170 Green. The font type is FHWA Hwy. Series "D" unless otherwise specified. The street name shall be 10-inch initial upper case letters with a combination of lower case letters, and the designator shall be 8-inch initial upper case with a combination of lower case letters.
- **LED Light Engine and Light Intensity** . LED drive current shall be regulated using a pulse width modulated 24-volt direct current (DC) drive and limited to approximately 300 mA through the LED chain at normal room temperature. A stable light intensity under varying voltage shall be provided having a color temperature of 6,500 degrees Kelvin (°K). Sign elements to be illuminated shall include the sign legend and background, in accordance with MUTCD section 2A.08. The entire surface of the sign panel shall be evenly illuminated.
- **Light Source**. The light source for the sign shall be LEDs that are mounted along the top or bottom edges of the sign. The LEDs shall evenly illuminate a light panel that is the same dimensions as the sign face. The LEDs shall have a minimum projected life of 60,000 hours and provide a color temperature of 6,500°K. LEDs shall be wired to incorporate fault tolerance or bypass to isolate LED failures of a particular LED, allowing remaining LEDs to operate normally. Thermal monitoring shall be provided to protect LED chains. Light sources shall be readily accessible through hinged doors or sliding panels.
- **Electrical.** The power supply shall be housed inside the sign frame assembly. Power supply shall be UL Class 2 limited output voltage and current plus isolation for safe operation, and UL Outdoor damp location rated. Power supply shall be IP66 Outdoor Rated.

- **Energy Requirements.** The overall power required shall not exceed 3 watts per square foot for single-sided signs, and 4 watts per square foot for double-sided signs.

  Photoelectric cell provision for photoelectric control shall be available. The photoelectric cell shall have a power unit that plugs into a twist lock receptacle mounted on top of the housing.

- **Environmental Specifications.** The sign shall be designed and constructed to withstand 150 mph wind loads in conformance with the requirements of the most recent edition of the AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals." The sign and power supply should be able to withstand and operate at temperature extremes of -40 degrees Celsius (°C) to +60 degrees °C. UL-approved neoprene gaskets shall be installed between the sign panel and fixture housing to prevent water or other debris from entering. Screened weep holes shall be provided on housing bottom for drainage.

Quality Assurance Manufacturer must be ISO 9001 certified.

- **Product Guarantee.** Product must be guaranteed for a minimum of 7 years.
- **Weight.** The overall weight of the complete sign assembly, including mounting hardware, shall not exceed 70 pounds for a 6-foot sign and 95 pounds for an 8-foot sign.

9.14.6 Traffic Signal Faces

All traffic signal faces (vehicular and pedestrian) shall be LED type unless otherwise specified by the City. The LED traffic signal faces shall conform to the following requirements:

- LED optical units shall be installed in accordance with the manufacturer's instructions.
- LED optical units shall meet or exceed the latest ITE Vehicular Traffic Control and Pedestrian Signal indication specifications. In addition to this, LED optical units shall conform to the following wattage requirements:
  - Max. 35 watts, +/-5 watts for 12-inch red, yellow, or green ball
  - Max. 15 watts, +/-5 watts for 12-inch red, yellow or green arrow
  - Max. 15 watts, +/-5 watts for PED hand and man symbol
  - Maximum total harmonic current distortion shall be less than 20%.
- Power factor shall be greater than 90%.
- Load balance requirement: load in one phase shall not exceed the load in any other phase by 15%.

Voltage operating shall be between 85 and 130 volts alternating current (VAC). Electronic circuitry shall assure proper operation of the load switch and monitor in the control cabinet.

The minimum number of LEDs per optical unit shall be as specified by the manufacturer to meet ITE luminance specifications for signal installation.

Manufacturer's warranty repair or replacement guarantee of 5 years covering all but accidental damage.

9.14.7 Electrical Cable

Signal cable shall be No. 14 AWG multiconductor, stranded, copper wire manufactured to meet IMSA Specification 19-1. Each conductor in the cable shall be individually insulated and rated at 600 volts.

Power service conductors shall be THWN soft-drawn copper, installed according to the NEC, and shall be black and white in color.

Ground wire shall be single conductor, No. 8 AWG, soft-drawn bare copper wire.

Luminaire wire shall be 12-2 plus ground and UL listed.

Pedestrian push-button and detector loop lead-in cable shall be shielded single or multiple twisted pairs in jacketed cable. Conductors shall be No. 14 AWG stranded copper continuous runs – no splicing to the cabinet. The pairs shall be twisted at least six turns per foot. The cable jacket shall consist of black, high-density polyethylene (HDPE). The jacket shall not be degraded by prolonged exposure to typical pavement runoff components. A stranded, tinned, copper drain wire shall be provided. The cable shall be suitable for operation at temperatures of -70°F to +170°F.

Loop detector wire shall meet IMSA specification 51.5. Loop detector wire shall be encased in quarter-inch-outer-diameter PVC or polyethylene tubing.

Optical detector lead-in cable for the emergency vehicle pre-emption optical detectors shall be GTT Model M138 or approved equivalent.

Where specified on the plans, overhead interconnect wire shall be a quarter-inch strand, galvanized-steel messenger cable integrated into the jacket to form a figure 8 cross-section and shall meet Rural Electrification Administration Specification PE-38.

9.14.8 Radio Communications Equipment

Where specified in the plans, radio communication shall be included on the project. The radio communication system shall be compatible with the existing spread spectrum radio system and meet the requirements set forth in the paragraphs below.

Data Radio Requirements: The spread spectrum radio transceiver will use a dual-band 2.4/5.8 megahertz (Mhz) frequency-hopping spread Spectrum Transceiver Encom 5800 series or approved equal. All associated cables and surge suppression equipment required to connect the radio shall be provided at no extra cost.

Master Antenna: The Master antenna shall be as specified on the plans, and the mounting arrangement shall be with the appropriate degree tilt to assure communications to all local transceivers. All associated cables and surge suppression equipment required to connect the antenna shall be provided at no extra cost.

Supplier Onsite Service: The supplier shall have a qualified, factory-trained, engineer or technician onsite when requested during the radio equipment installation.

9.14.9 Emergency Vehicle Detector

Optical detectors for emergency vehicle pre-emption shall be the GTT Model 711 Optical Detector or latest model, as needed. Placement of the detectors shall be determined by the City.

Timer modules for emergency vehicle pre-emption shall be the GTT Discriminator, Model 762, which handles two channels of detection. Modules shall be capable of locking out unauthorized users by means of emitter coding.

Optical emitter for emergency vehicle pre-emption shall be the GTT Model latest model. The emitter shall be programmable for priority and identification purposes via internal programming.

The Contractor shall notify the City when optical detectors are operational for testing prior to Final Acceptance.

9.14.10 Video Detection

Where specified on the plans, video detection shall be installed. The following describes the minimum requirements for providing a complete video detection system. Initially, the system shall be capable of providing vehicle presence detection at selected intersections. The video system shall be expandable without removing or replacing existing units. A four-channel video image processor and a two-channel expansion module shall be provided for each camera regardless of phasing unless otherwise noted.

Acceptable system is the Flir system. Using standard image sensor optics and in the absence of occlusion, the system shall be able to detect vehicle presence with 98% accuracy under normal conditions (days and nights), and 96% accuracy under adverse conditions (fog, rain, snow). All items and materials furnished shall be new, unused, current production models installed and operational in a user environment and shall be items currently in distribution. The product's algorithms shall have a proven record of field use at other installations for at least 2 years of service (in other words, not including prototype field trials prior to installation).

Video Vehicle Detection System – General: These technical specifications describe the minimum physical and functional properties of a video detection system. The system shall be capable of monitoring all licensed vehicles on the roadway, providing video detection for areas outlined in the construction drawings. The entire video detection system shall consist of the following:

- Video Image processing unit(s)
- Video camera(s) with infrared (IR) filter, enclosure, and sunshield
- Camera lens
- Surge suppresser
- All other necessary equipment for operation

9.14.10.1 Video Image Processing Unit Specifications

1) Software Specs:

The video image processing (VIP) unit shall be Flir Model VIP3D.1s or VIP3D.2s, the second releases of the VIP3 board. The new boards shall fit directly into the 170 and NEMA racks without an interface box. The VIP3D.1s shall monitor one camera, and the VIP3S.2s shall monitor two separate cameras. Video inputs to either unit shall enter through the input file or detector rack edge connector. The VIP unit shall be located on one module; daughter PC cards connected through ribbon cables shall not be allowed. On each camera, vehicle presence shall be detected on 24 zones. Counting data shall be stored for up to six different lanes. Up to 4,000 records shall be stored on board that can be retrieved via a RS232 port on the front. All zones (24 for two cameras) shall be able to be combined in different relationships (AND, OR, NOT) to 24 outputs. Twenty digital inputs shall allow expansion of the conditional outputs with external equipment. Also, conditional counting shall be possible. All zones and parameters shall be able to be changed without adversely affecting the detection. For example, when one of the zones is modified, all zones shall continue to work. When the new position is confirmed, the new zone shall enter a learning phase. Once the new zone has learned, it shall function properly.

Four detector configurations shall be able to be stored on board. Software download from PC via serial port shall be possible.

Specifications:

- 1 or 2 camera inputs

- 24 digital outputs
- 20 digital inputs
- Fits direct into the 170 and NEMA rack without additional adapter
- 24 direction-sensible detector zones per camera, including up to 6 counting zones per camera
- Stores counts for 4,000 intervals
- Detection results of all detection zones can be combined with the inputs to the related outputs AND, OR, NOT
- 4 configurations stored on board
- Modifications with no interruption on all zones
- Setup via keypad and monitor (no pointing device needed)
- Software update via RS232

The video detection board shall have only four outputs and shall use expansion boards for additional input and output.

The video detection (Main) board shall have the following on the front:

- One RJ11 connector for connection to expansion boards
- One Female DB9 for setup with keypad (Service port)
- LEDs for outputs on board (two for camera 1 and two for camera 2), power, Video Cam 1 and Video Cam 2, communication with expansions
- One video output for setup via keypad
- A switch to select which image to be on the service output

The input/ output expansion board shall have the following on the front:

- LEDs for power, expansion communication, input/ output activity
- Two DB9 ports for communication with Master or other expansion boards
- An 8-dipswitch device to select the following:
  - Input or Output Range: 1-12 or 13-24
  - Input or Output number (refer to example for more info)

2) PIN usage on 170:

   a) video detection (Main) board

There are four outputs free selectable over the two cameras. The master cannot have inputs.

The master shall have an RJ11 connector to be connected to the first operative (Exp Comm IN). The first operative (Exp Comm OUT) shall be connected to the second one (Table 9-6).

Table 9-6. [VIP specifications 1]

	TB2	TB1
SP	SPARE	SPARE
F	DET #1 Out	DET #2 Out

	TB2	TB1
W	DET #3 Out	DET #4 Out
D	VIDEO #1 IN (+)	VIDEO #2 IN (+)
E	VIDEO #1 IN (-)	VIDEO #2 IN (-)
J	VIDEO OUT (+)	RS485 (+)
K	VIDEO OUT (-)	RS485(-)
L	EQ GND	EQ GND

Input File Connector	Function
A	DC-GND
B	+24 VDC
C	NOT USED
D	VIDEO #1 IN (+)
E	VIDEO #1 IN (-)
F	DET #1 OUTPUT
H	LOGIC GROUND
J	VIDEO OUT (+)
K	VIDEO OUT (-)
L	EQUIPMENT GROUND
M	AC-
N	AC+
P	VIDEO #1 IN (+)
R	VIDEO #1 IN (-)
S	DET #2 OUTPUT
T	LOGIC GROUND
U	RS485(+)
V	RS485(-)
W	DET #3 OUTPUT
X	LOGIC GROUND
Y	DET #4 OUTPUT
Z	LOGIC GROUND

b) Input/output expansion board

The operative card is only one slot wide. Two or four input/outputs can be used. With dipswitches, it is possible to select which output (defined in the VIP3) will be connected on the expansion board (Table 9-7).

Table 9-7. [VIP specifications 2]

	TB2	TB1
SP	SPARE	SPARE
F	DET #A In/Out	DET #C In/Out
W	DET #B In/Out	DET #D In/Out
D	NC	NC
E	NC	NC
J	NC	NC
K	NC	NC
L	EQ GND	EQ GND

Input File Connector	Function
A	DC-GND
B	+24 VDC
C	NOT USED
D	NOT USED
E	NOT USED
F	DET #A INPUT/OUTPUT
H	LOGIC GROUND
J	NOT USED
K	NOT USED
L	EQUIPMENT GROUND
M	AC-
N	AC+
P	NOT USED
R	NOT USED
S	DET #C INPUT/OUTPUT
T	LOGIC GROUND
U	NOT USED
V	NOT USED
W	DET #B INPUT/OUTPUT
X	LOGIC GROUND
Y	DET #DINPUT/OUTPUT
Z	LOGIC GROUND

9.14.10.2 Video Camera

1) Camera

- One-third-inch color charge-coupled device (CCD)
- 650 television (TV) lines horizontal resolution
- 0.05 lux minimum illumination
- Digital wide dynamic range
- Up-the-coax on-screen display (OSD) controller (option)
- Can be set to Color, Day/Night, or black and white modes (camera is not IR sensitive)

2) Lens

- 10X zoom range
- 6.5 to 65-millimeter (mm) focal length
- 40.5 to 4.2-degree horizontal field of view

Model	TC660AZD65
Image Sensor	1/3" Interline Transfer Color CCD
TV System	NTSC
Picture Elements (pixels)	768 (H) x 494 (V)
Horizontal Resolution	650 TV Lines
Min. Illumination	0.05 lux
Signal-to-Noise Ratio	More than 50 cfs
Video Output	1Vp-p 75 ohm
Auto-Iris Drive	DC or Video Type (-pin square connector)
White Balance	ATW/AWC/Manual
Electronic Iris	1/60-1/100,000 – On/Off Selectable
BLC (Backlight Compensation)	On/Off Selectable (5 zones)
AGC (Automatic Gain Control)	0, 10, 18, 24 dB selectable (Off, Low, Middle, High)
Digital Wide Dynamic Range (WDR)	On/Off Selectable
OSD Options	Privacy Zone – On/Off Selectable (six Programmable zones)/Mirror Monitor – CRT LCD User/DNR On/Off, Level/Camera Title
Day/Night Function	Color/B&W/Auto (camera is not IR sensitive)
RS-485 Input	Pelco – D
Power Requirement	12-24VAC/DC +/-10%, 250mA Max
Synchronizing System	Internal
Operating Condition	+14°F to 122°F (-10°C to +50 degrees C) within 85% RH
Lens Mount	CS with Cam-type Back-focus Adjustment
Dimensions: w/h/d	2.6 x 2.6 x 7.6 inches (90 x 58 x 192.6 mm)

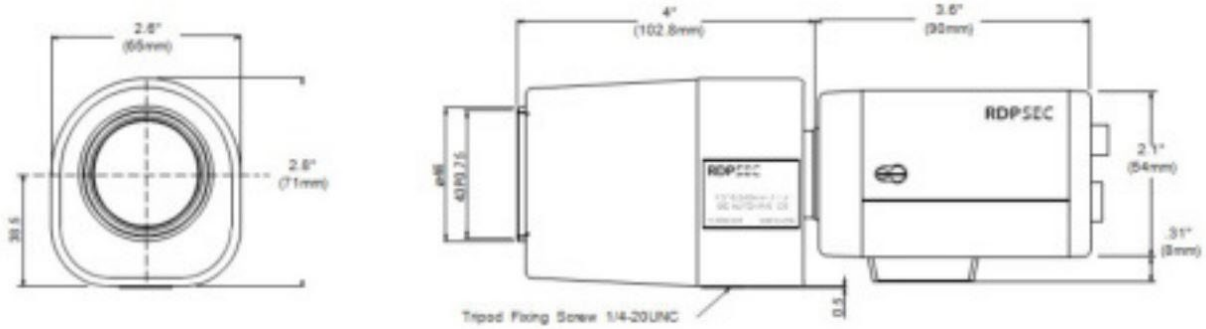
Model	TC660AZD65
Weight	1.2 lbs (520 g)
Zoom Lens	6.5 to 65 mm F 1.4 motorized zoom/focus with DC auto-iris 40.5” to 4.2” horizontal field of view

Notes:

cfs = centroid frequency-shift
dB = decibel(s)
g = gram(s)
lbs = pound(s)
mA = milliampere(s)
NTSC = National Television System Committee
RH = relative humidity

3) Video Camera Housing

Figure 9-1. Video Camera Housing

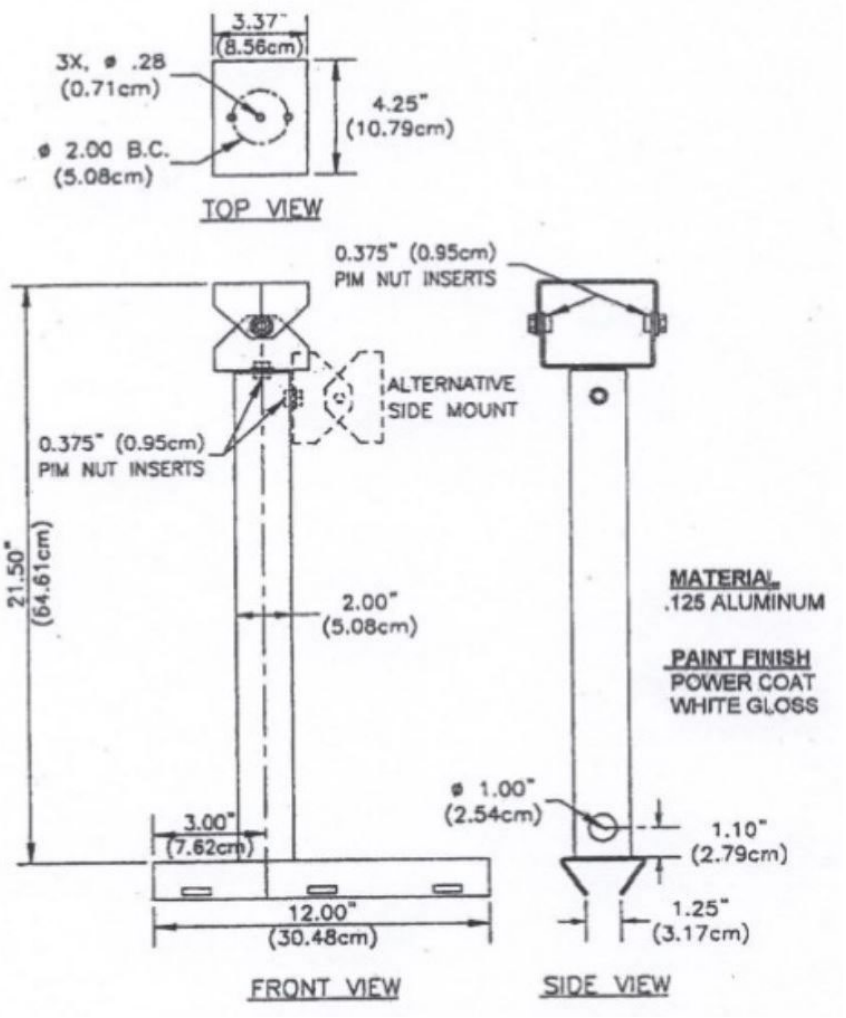


9.14.10.3 Housing and Sunshield

- General
  - All aluminum construction
  - IP68/NEMA-6P rated
  - Adjustable sunshield
  - Thermostatically controlled window heater/defogger
- Environmental
  - Temperature: -40° to 140°F (-40°C to +60°C)
  - Salt Atmosphere: MIL-STD-810E, Method 509, Procedure 1
- Safety
  - CE: LVD Requirements: 72/34/EEC; EN60065
  - UL: UL2044
  - cUL: CSA 22.2, No. 1
- Electrical
  - 115VAC 50/60Hz
  - 30 watts
- Dimensions and Weight
  - Without sunshield (w/h/d): 4.0 by 4.4 by 18.4 inches (100 by 112 by 468 mm)
  - 10.5 lbs (4.8 kilograms)
- Warranty
  - 5-year warranty

9.14.10.4 Universal Mount

Figure 9-2. Universal Mount



9.14.10.5 Cable

DESCRIPTION	6 CONDUCTOR COMPOSITE CABLE: 16 AWG 5 CONDUCTOR 19/29 BARE COPPER .016" LDPE, OVERALL CLEAR MYLAR WRAP, 20 AWG 1 CONDUCTOR SOLID BARE COPPER .080" PE. OVERALL 96% TINNED COPPER DOUBLE BRAID. .032 PE JACKET BLACK; OVERALL .030" PVC JACKET BLACK 105C DIRECT BUR & SUN RES RESISTENT			
CONDUCTOR/PAIR COUNT:	5 CONDUCTOR	1 CONDUCTOR	**CABLE LAY**	N/A
GAUGE & STRANDING	16 AWG 1929 BC	20 AWG SOLID BC	**BINDER**	N/A
D.C. RESISTANCE	3.35 Q/MFT	10.13 QMFT	**JACKET THICKNESS**	.030"
PRIMARY INSULATION TYPE	LDPE	PE	**JACKETCOLOR**	BLACK
INSULATION THICKNESS:	.016"	.080"	**JACKET MATERIAL**	PVC
COLOR CODE	BLACK, BROWN, WHITE, BLUE RED	N/A	**RIPCORD**	YES
SHIELD	N/A	90% TC BRAID	**NOMINAL O.D.**	XXX
TAPE	Q CM WRAP	N/A	**VOLTAGE RATING**	N/A
SHIELD	N/A	96% TC BRAID	**TEMP RATING**	105c
JACKET THICKNESS	N/A	.032"	**UL TYPE OR STYLE**	N/A
JACKET COLOR	N/A	BLACK	**PACKAGING**	TBD
JACKET MATERIAL	N/A	PE	**COPPER WEIGHT**	41.075 LBS/MFT
			SHIPPING WEIGHT	105 LBS/MFT
PRINT LEGEND				
AM SIGNAL INC 75 OHM VIDEO COAX 15 AWG 5 CDR 600 V DR BUR & SUN RES				

Surge Suppressor

A video interface panel shall be available for installation inside the traffic signal controller cabinet. The panel shall provide coaxial cable connection points and an EDCO CX06-BNCY or approved equal transient suppresser for each image sensor.

- Peak Surge Current (8 x 20 us) 5 kiloamperes
- Technology Hybrid, Solid State
- Attenuation 0.1db @ 10Mhz
- Response Time < 1 nanosecond
- Protection Line to Ground
- Shield to Ground (isolated shield modules)
- Clamp Voltage 6 volts
- Connectors BNC
- Impedance 75 ohms
- Temperature -40℃ to +85℃
- Humidity 0 to 95% non-condensing
- Dimensions 4.5 inches by 1.5 inches by 1.25 inches
- UL Listed UL 497B

Installation and Training

The product supplier of the video detection system shall supervise the installation and the testing of the video equipment. A factory-certified representative from the manufacturer shall be onsite during installation. The factory representative shall install, make fully operational, and test the system as indicated on the intersection drawings and this specification. Video detection cameras shall be mounted using “Band-It” banding material only (not hose clamps).

Warranty

The video detection system shall be warranted against manufacturing defects in materials and workmanship for a period of 2 years from date of installation. The video detection supplier shall provide all documentation necessary to maintain and operate the system.

9.14.11 Microwave Vehicle Radar Detector

Where specified on the plans, microwave vehicle radar detection shall be installed. The microwave radar vehicle detector shall be the Wavetronix Smart Sensor Matrix, or approved equal, for all approaches with advance detection for main street approaches on Major-Minor intersections and all approaches for Major-Major intersections.

9.14.12 Pedestrian Detector

Pedestrian push buttons shall be as specified in 9.120b or approved equal as called out in the signal construction plans. They shall be of tamper-proof design, and the housing shall be yellow in color.

A two-wire Polara iNavigator (iN2) Bluetooth-enabled Audible-Tactile Pedestrian system composed of a pedestrian Head Controller Unit and Push Button Stations with integral pedestrian signs meeting the functionality requirements of MUTCD 2009 – 4E. The Contractor shall coordinate with the City and the vendor to provide audio messaging files meeting MUTCD 4E.11 specification and approved by the City with the equipment and to the City for backup purposes at no additional cost to the City.

9.14.13 Pedestrian Push Button Sign

Pedestrian push button signs shall be integral to Polara iNavigator (iN2) APS push button station or as indicated in the plans. Pedestrian signage shall be a MUTCD R10-3e 9-inch-by-15-inch sign.

9.14.14 Mast Arm and Pole

Mast arms and poles shall meet the requirements of the standard details, which indicate the critical dimensions that must be met exactly or within stated tolerances. The intent is to provide mast arms and poles that match the overall appearance as illustrated in the standard details and meet the performance requirements of the details and these specifications. Pole supplier submittals shall demonstrate conformity with this intent.

Mast arms and poles shall be wrapped for shipping from the factory in heavy-duty paper or plastic, to protect them from scratches and abrasions in transit.

Mast arms and poles shall be factory-coated conforming to standard detail requirements.

Specialty signal poles, such as modular or nostalgia designs, may only be installed with approval from the City. The entity paying for the signal will be required to have spare components available and stored near the City in case of pole failure, required replacement, or other emergency.

Mast arms shall not be installed and left unloaded for an extended period of time. If, at the discretion of the City, the mast arms are installed, and loading cannot occur by installing signal heads or mast arm signing, the mast arms shall be loaded with a minimum of two sign panels on each mast arm. These sign panels shall be mounted with Astro brackets so a gap is maintained between the mast arm and the sign panel. These sign panels shall be spaced at one-third intervals on the mast arm. The sign panels shall be mounted parallel with the roadway on the top of the mast arm. The Contractor shall then contact the City so the mast arm and signal pole can be inspected for excessive vibration. Additional sign panels or adjustments in sign-panel spacing may be required at the discretion of the City.

9.14.15 Span Wire Pole

Unless otherwise specified in the plans and specifications, span wire poles are intended for temporary use only, prior to installation of permanent mast arm signals or for emergency use. In all cases, span wire signals will be allowed only with written authorization of the City.

Span wire poles and cable shall be designed to meet the structural requirements given in the latest edition of AASHTO's "Standard Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals" for a wind velocity of 90 mph. The minimum pole weights and span wire cable rating given in the standard details shall be increased as necessary in accordance with the AASHTO requirements.

Span wire pole may be seamless or may be fabricated as one piece without transverse joints or welds and with only one longitudinal seam, which shall be either continuously welded and ground or rolled flush.

Span wire cable shall be seven-wire stranded, common galvanized, and utilities grade. The cable shall have a minimum wire diameter of three-eighths of an inch and shall be rated at 13,000 pounds minimum. Tether cable shall have a maximum diameter of one-quarter inch and shall be stranded, galvanized steel. Both span wire cable and tether cable shall be incidental to the span wire pole pay item.

9.14.16 Pedestal Pole

Pedestal poles shall be designed to meet the structural requirements given in the latest edition of AASHTO's "Standard Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals" for a wind velocity of 100 mph. The pole base shall be frangible. All ped poles shall include Pelco pole and base collar assembly #PB-5334.

The pedestal pole shall also meet the requirements as stated in Section 9.14.14 of these specifications.

9.14.17 Pedestrian Push Button Pole

Pedestrian push button pole shall be as illustrated in the standard details and installed at locations shown on the plans. When indicated on the plans, push buttons, pedestrian signs, and instructional signs shall be mounted on the pedestrian push button pole.

9.14.18 Controller and Cabinet (Local/Master)

Each controller and cabinet assembly shall be in conformance with the latest edition of the City of Castle Pines Traffic Signal Specifications, as clarified by the following.

Each controller and cabinet assembly shall include:

1) When a 2070 controller is required, the following shall be provided: 2070 LITE controller per CALTRANS standards with software compatible with signal system software. A 2070-7B module shall be installed in place of the 2070-7A module.
2) A 332D cabinet with an exterior painted CDOT silver with an anti-graffiti coating; interior shall be painted white. Cabinet shall be furnished with a "BEST" door lock kit. Lock and core is "BEST" 5L6R left and right.

The cabinet shall contain the CalTrans PDA#2 power distribution assembly. Hinged covers shall protect all circuit breaker switches. The assembly shall contain a quick-release locking latch in front of the 206-power supply. Other specific items shall be as follows:

- Quad fans with two thermostats for 332D cabinets: fans shall be wired on independent circuits.
- Dual input files
- Output File. It shall contain a hot swappable red monitor board with a protective cover mounted on the outside rear of output file. An 8-position load resistor termination panel shall also be included and mounted on the assembly.
- Auxiliary Output File
- Six Model 430 transfer relays
- Model 204 2-circuit flashers
- Eighteen Model 200 input/output load switches
- Model 242 D.C. isolators
- Model 2018E Reno conflict monitor or approved equivalent
- CalTrans/CDOT pullout drawer assembly
- Interior shelf
- Internal (front/back) LED lamp assemblies. No more than two light strips per power supply.
- Service panel assembly with main breaker, including terminal blocks for service and battery back-up system. Transient voltage surge suppression shall be a removable/plug-in type, Hesco/RLS HE1750 TEES or approved equal.
- Polymer concrete cabinet base pad
- 72000 EtherWAN hardened managed network switch
- Gator Patch 12 Port pre-terminated patch panel SC connector or approved equal as specified on plans
- Electronic copy of all cabinet documentation, including the cabinet manual and cabinet prints, shall be provided on a flash drive.
- 332/332D Cabinet Equipment Layout – Top to Bottom
- Front Right (facing cabinet):
  - Ethernet switch
  - 2070L Controller
  - CalTrans/CDOT pullout drawer
  - "I" File
  - "J" File
  - PDA Assembly

  - Output file
  - Aux Output file
- Front Left (facing cabinet):
  - Gator Patch Panel
  - UPS Head Unit
  - Transfer Switch
  - Wavetronix file (as needed)
  - Shelf
  - CalTrans/ CDOT pullout drawer
  - Bottom shelf

Notes:

- The cabinet drawings shall be non-fading prints using the xerography method. No blue line drawings will be acceptable.
- The City Public Works Department shall be supplieda computer printout of the complete environmental testing results.
- The cabinet shall have 14 red flash jumper blocks with 10 additional jumpers to accommodate yellow flash.
- The cabinet field terminals shall be silk screened with the appropriate phase/color designations. Field wire attachment point in the cabinet shall be a 12-position terminal block with screw-down plugs.

The controller and cabinet shall be delivered to the City of Castle Pines Traffic Signal Shop for testing, programming, and operational checking. No testing shall commence until cabinet is completely assembled by the Contractor (for example, UPS and communication equipment). City Public Works Department staff will have the complete cabinet available for pickup no more than 10 working days after final testing. Contractor is responsible for delivery and pick-up. Any malfunctions or problems with the testing and programming will be reported to the Contractor for immediate repair. Any malfunctions or problems will not count against the 10 working days.

9.14.18.1 Uninterruptible Power Source

Unless otherwise indicated, UPS shall be installed. The UPS shall be Alpha FXM1100 with Ethernet SNMP card, transfer switch (U-ATS and U-GTS), battery string monitor (Alpha Guard), heater mats and equipped with Alpha Cell 195 GXL batteries having a minimum rating of 100 amp hours or approved equal.

Documentation and Warranty The manufacturer shall furnish the owner an instruction manual covering the installation, operation, and maintenance of the UPS and batteries. The UPS shall be covered by a parts and labor warranty in accordance with the manufacturer's Standard Terms and Conditions. The warranty period shall be for 2 years from in service date.

9.14.19 Miscellaneous Hardware

All ferrous mounting hardware and weatherheads shall be galvanized, cadmium plated, or made of stainless steel to resist corrosion. Payment for miscellaneous hardware, including pole plates for side-of-pole mounting, shall be incidental to the pay item to which the miscellaneous hardware items are attached.

9.14.20 Instructions and Wiring Diagrams

All equipment shall be provided with a minimum of two sets of complete installation and operating instructions, including a chart of field connections, as well as a service manual for the controller containing service instructions, wiring diagrams, and trouble-shooting procedures. Each and every component used shall be clearly referenced in the service manual, and its value, ratings, and manufacturer part number shall be given. Schematics shall be provided for all electronic equipment.

9.14.21 School Flashing Beacon Assembly

A school flashing beacon assembly shall be as shown in the standard details. Payment for this item shall be inclusive of all work to provide an operational flashing assembly, including materials, installation, and electrical service connection (if not a solar installation). Fluorescent yellow-green signs shall be installed as an integral part of the flashing assembly.

9.14.22 Warning or Regulatory Sign Flashing Beacon Assembly

A warning or regulatory sign flashing beacon assembly shall be as shown in the standard details. Payment for this item shall be inclusive of all work to provide an operational flashing assembly, including materials, installation, and electrical service connection (if not a solar installation). Signs shall be installed as an integral part of the flashing assembly.

9.14.23 Fiber-Optic Cable

9.14.23.1 Industry Standards

Fiber-optic cable shall conform to the industry standards listed as follows to assure the cable's performance and durability in the field environment:

- Electronic Industries Alliance (EIA)
- Insulated Cable Engineers Association (ICEA)
- International Electrotechnical Commission (IEC)
- International Organization of Standardization (ISO)
- International Telecommunication Union – Telecommunication Standardization Sector (ITU-T)
- Telcordia Technologies, Inc. (Telcordia)
- Telecommunications Industry Association (TIA)
- United States Department of Agriculture Rural Utilities Service (RUS)

The industry standards shown in the Table 9-10 shall be referenced throughout this section by its Section Standard Number (SSN). The Contractor shall be responsible for using the most current edition or version of the standards listed in Table 9-10 or the replacement standard if the standard has been superseded.

Table 9-10. Industry Standards

SSN	Standard	Edition	Fiber Optic Test Procedure	Standard Title
10-1	TIA-526-7	A	7	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
10-2	TIA-455-78	B	78	Optical Fibers Attenuation Measurement Methods and Test Procedures
10-3	ITU-T G.652D	2009	N/A	Characteristics of a Single-Mode Optical Fiber and Cable

SSN	Standard	Edition	Fiber Optic Test Procedure	Standard Title
10-4	TIA-455-3	B	3	Procedure to Measure Temperature Cycling Effects on Optical Fiber Units, Optical Cable and Other Passive Components
10-5	EIA-359	A	N/A	Color for Color Identification and Coding
10-6	TIA-598	D	82-B	Optical Fiber Cable Coding
10-7	TIA-455-82	B	81	Fluid Penetration Test for Fluid Blocked Fiber Optic Cable
10-8	TIA/EIA-455-81	B	41	Compressive Loading Resistance of Fiber Optic Cables
10-9	TIA/EIA-455-41	A	104	Fiber Optic Cable Cyclic Flexing Test
10-10	TIA-455-104	B	25	Impact Testing of Optical Fiber Cables
10-11	TIA/EIA-455-25	D	33	Optical Fiber Cable Tensile Loading and Bending Test
10-12	TIA-455-33	B	85	Fiber Optic Cable TwistTest
10-13	TIA-455-85	A	226	Calibration of Optical Time-Domain Reflectometers
10-14	TIA/EIA-455-226	2002	231	Calibration of Fiber Optic Power Meters
10-15	TIA-455-231	2015	N/A	General Requirements for the Competence of Testing and Calibration Laboratories
10-16	ISO/IEC 17025	2nd	N/A	General Requirements for the Competence of Testing and Calibration Laboratories
10-17	TIA-455-37	A	37	Low or High Temperature Bend Test for Fiber Optic Cable
10-18	TIA/EIA-455-98	A	98	Fiber Optic CableExternal Freezing Test
10-19	Telcordia GR-20 CORE	4	N/A	Generic Requirements for Optical Fiber and Optical Fiber Cable
10-20	ISO 9000	4th	N/A	International Standards for Quality Management
10-21	ICEA S-87-640	6th	N/A	Optical Fiber Outside PlantCommunications Cable
10-22	RUS PE-90a	N/A	N/A	Minimum Performance Specifications for Fiber Optic Cables
10-23	IEEE C2	2017	N/A	National Electrical Safety Code (NESC)

9.14.23.2 Fiber-Optic Material Specifications

1) Where specified on the plans, interconnect wire connecting traffic signal controller cabinets shall be fiber-optic type.

2) Fiber-optic cable runs consist of a backbone cable, which runs the length of the project, and lateral connections to the individual local controller cabinets and material specifications for each are explained in detail in this specification:

a) Backbone fiber-optic cable shall be loose tube, non-armored, outdoor cable consisting of (72 single-mode fibers unless otherwise specified on the plans.

b) The lateral fiber-optic cable shall be loose tube, non-armored, outdoor cable with fiber count as indicated on the plans and complying with the following specification for fiber-optic cable: Lateral cables shall include a pre-terminated type termination panel, similar to Fiber Connections GatorPatch panel, Corning Zeux Panel, or approved equal, and shall be spliced to the backbone fiber-optic cables in the splice closure as specified in the plans or Project Specifications, or as directed by the City or its designee.

3) Fiber-optic cable for installation in conduit shall meet the requirements of SSN 10-3.

9.14.23.3 General Considerations

1) The cable shall be new, from an unused reel, and of current design and manufacture.

2) Connectors shall be "SC" single-mode type with a UPC finish (nominal reflectance of -50 dB), unless otherwise specified on the plans.

3) A No. 14 AWG (minimum), fully annealed, solid conductor tracer wire shall be installed in conduit with fiber. The tracer wire shall use HDPE insulation and the American Public Works Association color code standard for buried communications.

9.14.23.4 Fiber Characteristics

1) All fibers in the cable must be usable fibers.

2) The cable and jacket shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

3) Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

4) The single-mode fiber used in the cable specified herein shall conform to SSN 10-3 except as noted herein.

9.14.23.5 Fiber Specification Parameters

All fibers in the cable shall meet the following requirements:

1) Have attenuation values of 0.35 decibel per kilometer (dB/km) at 1,310 nanometers (nm) and 0.25 dB/km at 1,550 nm.

2) Temperature testing shall be in accordance with SSN 10-4.

3) The chromatic dispersion for single-mode optical fibers shall be as required by SSN 10-3.

4) Specifications for Outdoor Fiber Cables

a) Optical fibers shall be placed inside loose buffer tubes.

b) All cable shall be dielectric.

c) Up to 36 fibers per cable shall have 6 or 12 fibers per buffer tube, and greater than 36 fibers per cable shall have 12 fibers per buffer tube.

d) The fibers shall not adhere to the inside of the buffer tube.

e) The ultraviolet acrylate-coated fibers shall be color coded with highly distinguishable colors according to the following:

   i) Blue
   ii) Orange
   iii) Green
   iv) Brown
   v) Slate
   vi) White
   vii) Red
   viii) Black
   ix) Yellow
   x) Violet
   xi) Rose
   xii) Aqua

f) All colors shall meet Munsell standards as specified in SSN 10-5 and 10-6.

g) Buffer tubes containing fibers shall also be color coded or numbered with distinct and recognizable colors or numbers according to the following:

   i) Blue
   ii) Orange
   iii) Green
   iv) Brown
   v) Slate
   vi) White
   vii) Red
   viii) Black
   ix) Yellow
   x) Violet
   xi) Rose
   xii) Aqua

h) These colors shall meet SSN 10-5 and 10-6.

   i) In buffer tubes containing multiple fibers, the colors or numbers shall be stable during temperature cycling and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

   ii) Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.

   iii) Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

iv) The central anti-bucking member shall consist of a fiberglass-reinforced plastic rod. The purpose of the central member is to prevent cable buckling.

v) Each buffer tube shall be filled with a swellable yarn (dry water blocking) meeting the requirements of SSN 10-19, 10-21, and 10-22.

vi) Buffer tubes shall be stranded around a central member using the reverse oscillation, or "SZ," stranding process.

vii) The cable core interstices shall be filled with a swellable glass yarn, and the buffer tubes shall be surrounded by a dry water-blocking tape meeting the requirements of SSN 10-19, 10-21, and 10-22.

viii) Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic and dielectric with low shrinkage.

ix) The cable shall contain at least one ripcord, unless cable is using fast-access technology, under the sheath for easy sheath removal.

x) Tensile strength shall be provided by high-tensile-strength aramid yarns, fiberglass yarns, or both.

xi) The high-tensile-strength aramid yarns and/or fiberglass yarns shall be helically stranded evenly around the cable core.

xii) All cables shall be sheathed with medium-density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and dry water-blocking materials. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

xiii) The jacket or sheath shall be free of holes, splits, and blisters.

xiv) The cable jacket shall contain no metal elements and shall be of a consistent thickness.

xv) Cable jackets shall be marked with the following items:

- Fiber-optic cable manufacturer's name, logo, or both
- Month and year of manufacture
- Fiber-optic cable manufacturer's part number
- Fiber count
- Sequential length markings in feet or meters
- Telecommunication handset symbol, as required by section 350G of SSN 10-23.

All length markings shall be placed at 2-foot, 3-foot, or 1-meter intervals. The actual length of the cable shall be within ±3% of the length markings. All markings shall be indented in permanent white characters. The height of the marking shall be approximately 2.5 mm. If remarking is required, yellow markings shall be used to correct the error in the original markings. All cable markings shall be in English.

i) General Fiber Cable Performance Specifications

i) The unaged cable shall withstand water penetration when tested with a 1-meter static head or equivalent continuous pressure applied at one end of a 1-meter length of filled cable for 24 hours. No water shall leak through the open cable end. When a 1-meter static head or equivalent continuous pressure is applied at one end of a 1-meter length of aged cable for 1 hour, no water shall leak through the open cable end. Testing shall be done in accordance with SSN 10-7.

ii) When tested in accordance with SSN 10-8, the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 80°C. If material flow is detected, the weight of any compound that drips from the sample shall be less than 0.05 gram (0.002 ounce).

iii) The cable shall withstand a minimum compressive load of 220 Newton centimeters (125 pound-force) for non-armored cables applied uniformly over the length of the compression plate. The cable shall be tested in accordance with SSN 10-9, except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1,550 nm (single-mode). The repeatability of the measurement system is typically ±0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

iv) When tested in accordance with SSN 10-10, the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ±1 cycles per minute, with a sheave diameter not greater than 20 times the cable diameter. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1,550 nm (single-mode). The repeatability of the measurement system is typically ±0.05 dB or less. The cable jacket shall exhibit no cracking or splitting when observed under 5 times magnification.

v) When tested in accordance with SSN 10-11, the cable shall withstand 25 impact cycles. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1,550 nm (single-mode). The repeatability of the measurement system is typically ±0.05 dB or less. The average increase in attenuation for fibers shall be less than or equal to 0.04 dB at 1,300 nm (multimode). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.

vi) When tested in accordance with SSN 10-12, using maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2,700 Newtons (N) (608 lbf) applied for 1 hour (using Test Condition II of the procedure). In addition, the cable sample, while subjected to a minimum load of 2,660 N (600 lbf), shall be able to withstand a twist of 360 degrees in a length of less than 3 meters. The magnitude of the attenuation change shall be within the repeatability of the measurement system of 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1,550 nm. The repeatability of the measurement system is typically ±0.05 dB or less. The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 890 N (200 lbf).

vii) When tested in accordance with SSN 10-13, a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting. The magnitude of the attenuation change will be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change greater than 0.1 dB at 1,550 nm. The repeatability of the measurement system is typically ±0.05 dB or less. The cable jacket will exhibit no cracking or splitting when observed under 5 times magnification after completion of the test.

viii) Low and high temperature cable bending, maximum bend radius, and cable aging shall be tested in accordance with SSN 10-17.

ix) Cable freezing shall be tested in accordance with SSN 10-18.

x) Color-coding permanence shall be tested in accordance with SSN 10-19, 10-21, and 10-22.

xi) In accordance with SSN 10-4, the fiber-optic cable shall conform to the following temperature requirements:

Operation	-40°C to 70°C (-40°F to 158°F)
Installation	-30°C to 60°C (-22°F to 140°F)
Shipping/Storage	-40°C to 75°C (-40°F to 167°F)

9.14.24 Quality Assurance Provisions

1) Optical fiber shall meet SSN 10-20 standards.
2) Optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kilopounds (kip) per square inch.
3) Optical fibers shall be 100% attenuation tested by the manufacturer. The attenuation of each fiber shall be provided with each cable reel.

9.14.25 Packaging

1) The complete cable shall be packaged for shipment on non-returnable wooden reels.
2) Text on the reels shall contain the following information:
   a) Fiber-optic cable manufacturer's name, logo, or both
   b) Fiber-optic cable type
   c) Fiber count
   d) Marking showing side to unreel cable
3) Top and bottom ends of the cable shall be available for testing without removing cable from the reel.
4) Both ends of the cable shall be sealed to prevent the ingress of moisture.
5) Each reel shall have a weatherproof reel tag attached identifying the reel and cable.
6) Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

9.14.26 Miscellaneous

The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

9.14.27 Fiber-Optic Cable Installation

1) Interconnect Cable Installation. The Contractor shall provide the City with two copies of the cable manufacturer's recommended installation instructions for fiber-optic cable in conduit. Installation shall be in accordance with these practices except as directed by the City or its designee. Additional cable costs as a result of damage caused by the Contractor's neglect of recommended procedures shall be the Contractor's responsibility.
2) Fiber-optic cable shall be installed in continuous runs except where cable type changes or where maximum pull lengths govern. The manufacturer's recommended limits for cable lengths shall not be exceeded.

3) Cable ends shall be stored in splice enclosures immediately adjacent to cabinets or in controller cabinets as directed by the City or its designee. Only fibers called out in plans need to be spliced. All other fibers shall be sealed in a manner recommended by the manufacturer.

4) The City or its designee shall provide an interconnect schematic diagram to the Contractor. The diagram shall clearly indicate cable routing, splice points, and fiber connections, including identifying the color-coded fibers and buffer tubes. Cable installation will not be permitted until the schematic diagram has been reviewed by the Contractor in the preconstruction meeting and with the City's or its designee's oversight during installation.

5) The fibers and buffer tubes noted on the plans shall be the only ones terminated or spliced, unless otherwise approved by the City or its designee. Under no conditions shall the single-mode fibers be cut or spliced at intermediate points without express written direction from the City or its designee. The Contractor shall place an end cap on any bare cable ends to prevent moisture or dirt intrusion.

6) Field terminations of fiber shall not be allowed without express written direction from the City or its designee.

7) The Contractor shall leave a minimum of 50 feet coiled in each pull box, a minimum of 10 feet within the controller cabinet, and 100 feet coiled in splice vaults, unless otherwise specified on the plans.

8) The maximum pulling tension shall be 2,700 N (600 lbf) during installation (short term) and 890 N (200 lbf) long-term installed as tested in accordance with SSN 10-12.

9) The Contractor shall seal all ends of conduit for pulled-fiber cable with approved duct seal products.

10) The Contractor shall place fiber tags on the ends of all pulled-fiber cable with the following information:

    a) Name of manufacturer

    b) Type of fiber (single mode or multi-mode)

    c) Number of strands

    d) Date of installation

    e) Cable end to end locations

    f) Lateral run identification (where applicable)

9.14.28 Fiber-Optic Cable Testing

1) The Contractor shall demonstrate that all fiber-optic cable testing results in acceptable attenuation values. All fiber-optic cable testing parameters shall be submitted as specified in this section and in Section 9.14.32.

2) The Contractor, solely at the Contractor's cost, shall resplice any fusion splices or re-terminate any terminations that have test results exceeding acceptable attenuation values. The Contractor, solely at the Contractor's cost, shall retest any fiber links that have been re-spliced.

3) The Contractor, solely at the Contractor's cost, shall bring any link not meeting the requirements of testing specifications into compliance.

4) The installed fiber-optic cable test shall consist of the testing of single-mode fiber-optic cable. The testing procedures involve an optical time domain reflectometer (OTDR) test and an optical power meter test. Under no circumstances shall fiber-optic testing begin before cable installation is complete, without the express written consent of the City.

5) Guidelines for fiber-optic cable testing are as follows:

   a) Launch box or test jumpers must be of the same fiber core size and connector type as the cable system: Single-mode fiber 8.3/125 micrometers (µm).

   b) The optical sources for testing are stabilized and have center within ±20 nm of the 1,310/1,550 nm single-mode nominal wavelength for testing in accordance with SSN 10-1.

   c) The power meter and the light source must be set to the same wavelength during testing.

   d) The OTDR and power meter must be calibrated at each of the nominal test wavelengths and traceable to National Institute for Standards and Technology calibration standards. The calibration of the OTDR and power meter shall conform to the requirements set forth in SSN 10-14 and 10-15, respectively.

   e) All system connectors, adapters, and jumpers are properly cleaned prior to and during measurements.

6) Materials for Testing

   a) Fiber-Optic Cable Testing Equipment

      i) Equipment shall be calibrated annually by the manufacturer or by an SSN 10-16 accredited calibration laboratory. A copy of the most recent certificate of calibration and any out-of-tolerance conditions shall be provided with project submittals prior to the initiation of any testing activities. The following equipment and information is required to perform fiber-optic cable tests:

         - OTDR
         - Launch box (minimum length – 300 meters, or 984 feet)
         - Light source at the appropriate wavelengths (1,310 and 1,550 nm)
         - Optical power measurement equipment capable of measuring optical power in decibels per milliwatt (dBm)
         - Minimum length for test jumpers shall be as recommended by the manufacturer of the light source and power meter. The connectors on the jumpers shall be compatible with the light source and power meter and have the same fiber construction as the link segment being tested in accordance with SSN 10-1. The Contractor shall also be responsible for providing any adapters, if needed.
         - Jacket length measurements for lateral and backbone cable at each cable end, including splice points and termination panels

   b) Optical Fiber Cable Testing with OTDR

      i) The Contractor shall perform an OTDR test of all fibers in all tubes on the reel, prior to installing the fiber. The test results shall be supplied to the City prior to cable installation. The preinstallation testing shall be used to evaluate the integrity, overall length, and fiber attenuation in dB/km for fiber-optic cables prior to the installation in conduit. The Contractor shall use a pigtail and mechanical splice to access one cable end to verify the length and attenuation of each fiber. The results of the testing shall be compared with the reel tag. Results indicating that the fiber-optic cable received does not meet the specification, or the discovery of point defects caused by shipping and handling shall be brought to the attention of the City or its designee immediately.

      ii) If the fiber is specified as "Install Only," the Contractor shall test the fiber on the reel and provide the test results to the City prior to the Contractor's accepting the cable. After

installation, if there are unused portions of cable remaining on the reel, the City may request the Contractor or other qualified technician to perform a reel test. The Contractor shall provide the City the test results prior to delivering the cable to the City. Any cable damaged while in the Contractor's possession shall be replaced at the Contractor's expense.

iii) Fiber testing shall be performed on all terminated fibers from patch panel to patch panel and unterminated fibers from end to end. Additionally, mid-entry splices into mainline cables require testing of all strands in the mainline cable, before and after installation. Testing shall consist of a bidirectional end-to-end OTDR trace performed in accordance with SSN 10-2 at both the 1,310- and 1,550-nm wavelengths. The attenuation measurements shall be provided at dual wavelengths 1,310 and 1,550 nm for single-mode fibers.

iv) OTDR inspection will be used to verify installed cable integrity and length. It will also be used to assess splices and connectors. OTDR signature traces will be used for documentation and maintenance.

v) Attenuation numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

vi) The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

vii) To ensure the traces identify the end points of the fiber under test and the fiber designation, the Contractor shall use a launch box, if required with the OTDR being used, to eliminate the "dead zone" at the start of the trace so that the start of the fiber under test can be identified on the trace. The length of the launch box shall be indicated for all test results.

viii) In compliance with SSN 10-2, the Contractor shall record the following information during the test procedure:

- Name and contact information for individuals responsible for conducting the test
- Type of test equipment used (manufacturer, model, serial number, calibration date and valid certification of calibration)
- Date test is being performed
- Jacket readings in and out of each splice vault and each pull box
- The index of refraction value used to perform the testing (1.466 for 1,310 nm and 1.467 for 1,550 nm in accordance with SSN 10-3)
- Optical source wavelength and spectral width
- Fiber identification
- Start and end point locations
- Launch box length
- Method of calculation for the attenuation or attenuation coefficient
- Acceptable link attenuation

c) Optical Fiber Cable Testing with Optical Power Meter

i) The Contractor shall conduct an optical power meter test for each fiber installed. Single-mode segments shall be tested in one direction at both the 1,310-nm and 1,550-nm wavelength.

ii) In compliance with SSN 10-1, the following information shall be recorded during the test procedure:

- Names and contact information of personnel conducting the test

- Type of test equipment used (manufacturer, model, serial number, calibration date, and valid certificate of calibration)
- Date test is being performed
- Optical source wavelength and spectral width
- Fiber identification
- Start and end point locations
- Test direction
- Reference power measurement (when not using a power meter with a Relative Power Measurement Mode)
- Measured attenuation of the link segment
- Acceptable link attenuation

d) Acceptable Attenuation Values

i) Acceptable attenuation values shall be calculated for each fiber tested. These values represent the maximum acceptable test values.

ii) Single-mode fiber. The general attenuation equation for any single-mode link segment is as follows:

- Acceptable Link Attenuation (Attn.) = Cable Attn. + Connector Attn. + Splice Attn.

iii) 8.3 µm Single-mode Attenuation Coefficients:

- Cable Attenuation = Cable Length (km) x (0.35 dB/km@1,310 nm and 0.25 dB/km@1,550 nm)
- Connection Attenuation = Number of Mated Connections x 0.50 dB
- Splice Attenuation (Fusion) = Splices x 0.10 dB

e) Test Procedures

i) Fiber testing shall be performed on all fibers in the completed end-to-end system.

ii) Single-mode fiber. The single-mode optical power meter fiber test shall be conducted as follows:

- Clean the test jumper connectors and the test coupling according to manufacturer's instructions.
- Follow the test equipment manufacturer's initial adjustment instructions.
- Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter (refer to Figure 9-3).
- If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (preferred). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations unless attenuation values can be read on the display directly in dB without calculations.
- Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
- Attach Test Jumper-1 to one end of the cable plant to be measured and Test Jumper-2 to the other end (refer to Figure 9-4).

- Record the Power Measurement. If the power meter is in Relative Power Measurement Mode, the meter reading represents the true value. Record the Relative Power Measurement if the meter does the calculation and provides this information.

Figure 9-3. Test Jumper 1 Connection

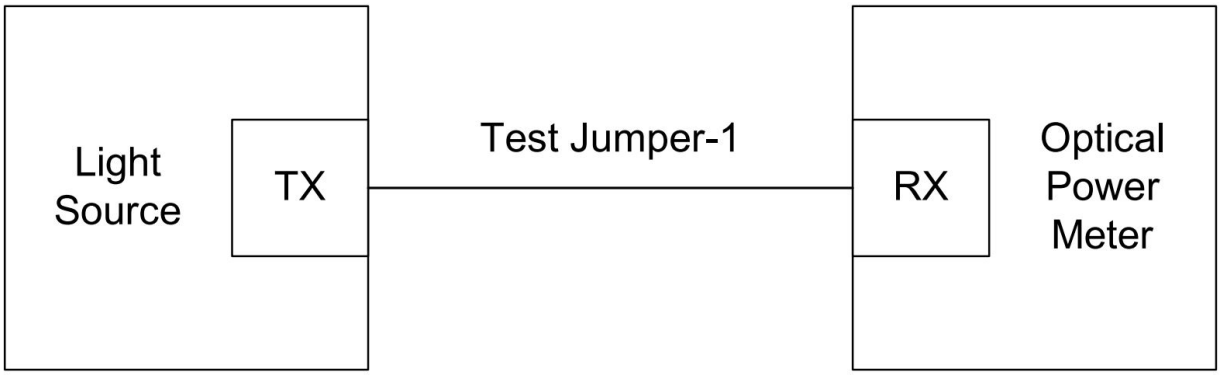
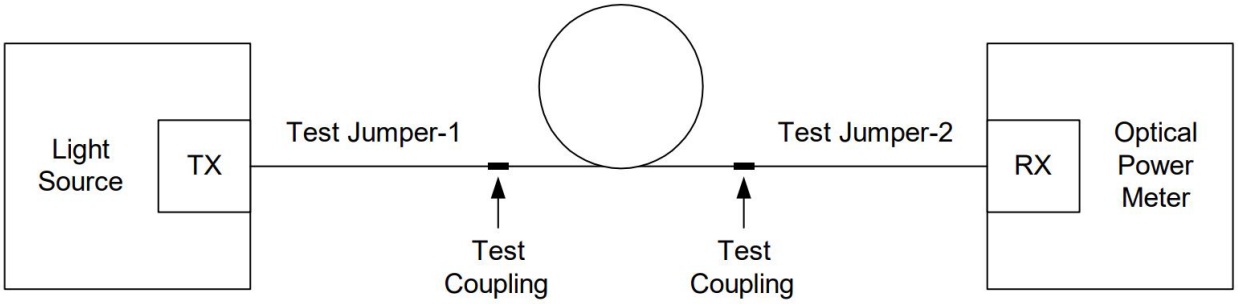


Figure 9-4. Test Jumper 1 to Test Jumper 2



9.14.29 Fiber Acceptance

Once the fiber-optic communication system is in place and passed the fiber testing requirements, it shall be made operational for a burn-in period test. During this time, the system will be exercised and monitored for a period of 30 calendar days to exhibit fault-free operation. During the 30-day burn-in period, the Contractor is responsible for the maintenance or repair of the system or systems. The cost of any maintenance or repair necessary, except electricity, damage by the public, or acts of God, shall be borne by the Contractor and will be considered as included in the price paid for the contract item involved; therefore, no additional compensation will be allowed. The City shall suspend the 30-day burn-in period when a problem is detected and then continue once the failure has been corrected.

9.14.30 Emergency and Non-emergency Repairs during Construction and Burn -in Period

The Contractor shall provide emergency maintenance and fiber restoration services on the project corridor(s) where fiber-optic communication systems are installed for the City Public Works Department based on the terms and conditions set forth in the executed Agreement. All unplanned service disruptions of fiber-optic communication systems along project corridors shall be considered an emergency unless otherwise identified by the City or its designee. The terms of this service shall be provided from the initiation of the Agreement through system acceptance at the successful completion of the burn-in period. The Contractor shall include its fees or compensation to provide these services as part of its executed Agreement. The Contractor shall have access to the fiber-optic system documentation that it prepares for City to assist in the emergency maintenance and fiber restoration activities. The City will provide the

Contractor with a project contact list to initiate contact about any disruptions in fiber-optic cable service. Project contacts will be responsible for notifying affected users of affected fiber-optic cable of any service disruptions. The City will also provide access permission for local work Permits, if needed, for restoration activities.

The City or a third party may provide the first response in the event of an emergency and contact the Contractor to repair the problem. The Contractor shall dispatch personnel to undertake each such repair no later than 1 half-hour after the City Public Works Department initially notifies the Contractor of the emergency. Personnel responding shall arrive within 1 hour after notification during regular working hours and within 2 hours during non-working hours after notification.

The Contractor shall conduct the following to support its activities under this section:

- Contractor shall provide a single point of contact to initiate restoration service.
- Contractor shall provide qualified employees and a supervisor, including skilled fiber-optic splicers.
- Response time shall be as noted in the previous paragraph.
- Upon starting the restoration services, Contractor technicians shall continue those services as expeditiously as possible until temporary emergency services are completed and the fiber link is again ready for service.
- Contractor crews shall be available 24 hours/ day, 7 days/ week from the initiation of the project through successful completion of the burn-in period.
- Contractor shall provide all tools, materials, and test equipment needed to perform repairs associated with restoration services.
- Contractor shall update record drawings and project documentation to reflect changes in the fiber-optic communication system caused by restoration activities.

Where emergency splicing is required, the Contractor may use temporary mechanical splicing until such time that fusion splicing can be performed to replace the temporary mechanical splice. The attenuation for mechanical splices shall not exceed 0.30 dB per splice.

In instances of repairs that are of a non-emergency nature and determined to be the Contractor's responsibility by the City, such repairs shall be undertaken at the site within 1 working day after the City notifies the Contractor of the needed repair.

Should the Contractor fail to perform any maintenance responsibilities within the prescribed time period(s), the City shall employ the services of the City's traffic signal maintenance contractor to perform said maintenance work. The Contractor shall reimburse the City for labor and equipment charges plus 15% for administration associated with the use of the City's traffic signal maintenance contractor. Labor, materials, and 15% will be subtracted from the total contract amount.

9.14.31 Submittals

The Contractor is responsible for submitting all fiber-optic equipment calibration documentation, testing information, and fiber-optic testing results as specified in Section 9.14.29.

Additional Submittals: The following test data, certificates of compliance, and material specifications shall also be included with testing results specified in Section 9.14.29.

- End-to-end attenuation data resulting from the measurement of the optical power loss between cable termination points using a stabilized light source and optical power meter.

- OTDR signature traces resulting from the pre- and post-installation measurements for cable integrity, overall length, fiber attenuation in dB/km, and losses associated with fusion splices and connectors at patch panels. Electronic copies shall include the required viewing software, if needed, for the City to interactively review, analyze, and print the traces.
- Certificate of compliance for end-to-end, connector, and splice loss to confirm test performance, compliance with stated loss requirements, and applicable warranty coverage for all individual connector and splice losses in the installed cable plant.
- Cable specifications provided by the cable manufacturer that define the minimum optical and mechanical performance guaranteed for the cable.

9.14.31.1 As-Built Submittal

The Contractor shall submit one copy of the complete contract plans, including additional drawings issued as part of any change orders, with any deviations clearly marked in color. Deviations to be noted include, but are not limited to, the following:

1) Fiber routing and location information
2) Fiber splice location
3) Fiber splice configuration
4) Patch panel locations
5) Installed cable lengths

9.14.31.2 Emergency and Non-emergency Repair Submittal

The Contractor shall submit one copy of the complete plans showing all fiber-optic cable repairs, including additional drawings issued as part of any repair work, with any deviations clearly marked in color. Deviations are to be noted and shall include the following, among others:

1) Repaired fiber routing and location information
2) Repaired fiber splice locations
3) Repaired fiber splice configuration
4) Patch panel modifications where applicable
5) Installed cable lengths necessary for repairs

The Contractor shall submit all fiber-optic equipment, material, and testing documentation related to any repair work as specified in Sections 9.14.29 and 9.14.32.

9.14.31.3 File Format

The Contractor shall submit fiber-optic interconnect documentation to the City as both a hard copy and electronic copy emailed through File Transfer Protocol site or contained in a portable USB drive.

9.14.32 Paint Equipment

9.14.32.1 Paint Existing Structures

1) Previously installed signal poles shall be field painted when indicated on the plans. When so indicated, all exterior surfaces shall be cleaned and examined for damaged paint, and any such damage shall be given a spot coat of primer and the entire exterior surface repainted. Previously painted surfaces,

whether finish or prime coated, shall be scuff sanded with particular attention paid to the lower 8 feet of the pole.

2) Pole inspection by the City prior to application of the finish coats is required. Two finish coats of paint selected by the City shall be applied over the primer or previously painted surfaces.

3) The painting shall be done in a neat and efficient manner and may be applied either by hand brushing or spraying. The City reserves the right to require the use of brushes for the application of paint should the work done by the paint-spraying machine prove unsatisfactory or objectionable.

4) Touch-up painting shall be completed at the direction of the City. Nicks and abrasions shall be cleaned, and the City shall designate the appropriate primer coat, and finish coat, if applicable.

5) When indicated on the plans, traffic and pedestrian signal heads shall be painted black.

9.14.33 Pavement Marking

9.14.33.1 Materials

If pavement overlay or reconstruction is programmed within 1 year of marking installation, the City may approve use of alternate marking materials.

9.14.33.2 Surface Preparation

1) New concrete pavement shall have all residues removed, such as mud, dirt, and curing compound. Removal shall be by water blasting, sand blasting, or other City-approved method.

2) New asphalt pavements shall be dry and free of dirt.

3) For all restriping on existing concrete or asphalt pavement, the surface shall be clean and dry. Cleaning shall be by water sweeping, air blasting, or other City-approved method. When directed by the City, the surface shall be ground.

4) Surface temperature shall be 50°F and rising for all pavement marking applications except preformed plastic. Surface temperature shall be 60°F and rising for preformed plastic markings.

5) When the surface temperature does not reach 50°F, the Contractor may, on approval of City, substitute designated pavement markings with temporary marking materials to be replaced with permanent materials when weather dictates. Temporary pavement markings shall be refurbished by the developer or Contractor, at their own cost, as determined by the City.

9.14.33.3 Installation

All pavement markings shall be applied per the manufacturer's recommendations unless otherwise authorized by the City.

9.14.33.4 Pay Item

Pavement markings shall be measured and paid for on a lineal-foot basis; Arrows and legends shall be paid for on a square-foot basis unless otherwise authorized by the City. Refer to CDOT Standard Specifications for Road and Bridge Construction in accordance with Section 627.

9.14.34 Guarantees and Warranties

9.14.34.1 General

All work completed by the Contractor shall be guaranteed against defects in workmanship or materials for a period of 2 years from the date of Initial Acceptance, excepting ordinary wear and tear, abuse, or neglect. Please refer to the City of Castle Pines Roadway Design and Construction Standards, Chapter 13 – Acceptance Procedures and Requirements, for explanation of the required 2-year warranty period and for Final Acceptance requirements.

9.14.34.2 Pavement Marking Warranty

The following warranty is required for pavement marking installations: One year with normal traffic wear. Material will not peel or lift in this time period. Approval of all work must be obtained from the City or its designee prior to the start of this warranty period.

9.14.34.3 Materials and Parts

The Contractor shall supply the City with all manufacturer warranties and guarantees covering materials and parts.

9.14.35 General Signal Design Requirements

9.14.35.1 Scope

This section describes general signal design requirements for use in City of Castle Pines. Variances from these requirements require written approval of the City.

9.14.35.2 Signal Head Placement and Sizes

1) For all installations, one signal head shall be provided centered over each exclusive left turn and through lane. If mast arms do not reach the left turn lane(s), the number and configuration of signal heads should be adjusted in consultation with the City. Far left and far right pole-mounted signal heads shall also be provided. The need for one signal head per right turn lane should be determined on a site-specific basis. The traffic signal design engineer (Engineer of Record) shall coordinate with the pole manufacturer to verify that the structure is adequate to accommodate the proposed loading.
2) Where left-turn arrows are included, at least two signal heads with left arrow sections shall be provided, with one of these located on the far left pole.
3) Pedestrian signal heads shall be provided for all marked crosswalks. Where pedestrian signal heads are provided, corresponding pedestrian push buttons shall be provided.
4) All mast arm and span wire-mounted signal heads shall have aluminum louvered backplates, black in color with a 2-inch, diamond-grade, fluorescent-yellow retroreflective border.
5) All vehicle signal sections shall be 12-inch LED. Pedestrian indications shall be LED (refer to Section 9.14).
6) Where mast arms extend over the left turn lane(s), left-turn-only sign(s) (R3-5) shall be provided. Double lefts may be covered with one left-turn-only sign (R3-5) per lane, or one double left-turn-only sign located over the lane line between the double lefts as directed per plan.
7) Where flashing yellow arrow left turn control is recommended for left turn operations, a custom 30-inch-by-36-inch "left-turn yield on flashing yellow arrow" pictorial (for the arrow – no starburst) sign shall be installed to the right of the left-turn signal indication.

9.14.36 Pole and Cabinet Placement

All signal poles, pedestals, and cabinets shall be placed a minimum of 3 feet from the face of a traffic signal item to the face of the curb where curbing is present, with a desired separation of 5 feet. The traffic control cabinet and base shall be placed on level ground with adequate room to access and maneuver around the cabinet. The cabinet location shall be such that it guarantees adequate visibility of intersection and approaching traffic from all directions. The same separations apply from the face of a traffic signal item to the outside edge of the shoulder where pavement and shoulder exist with no curbing. Where only pavement exists without shoulder and curbing, a minimum of 5 feet from the face of the traffic signal item to the edge of pavement shall be maintained, with a desired separation of 7 feet. Refer to Section 9.14.44.3.

9.14.37 Street Name Signs

Rigidly affixed street name signs shall be provided for all approaches. They shall be on 0.100 aluminum sign and shall consist of Diamond Grade LDP reflective material or equivalent. The ElectroCut film shall be 3M 1170 Green or equivalent. The font type is FHWA Hwy. Series C unless otherwise specified. The street name shall be 12-inch initial upper case and combination of lower case, and the designator shall be 8-inch initial upper case and combination of lower case.

9.14.38 Signal Conduit

Refer to Section 9.12 for requirements.

9.14.39 Interconnect

Requirements for traffic signal interconnect shall be determined on a site-specific basis. The traffic signal designer shall coordinate with the City or its designee to determine the need for interconnect.

9.14.40 Luminaires

Unless otherwise indicated in the plans, the Contractor shall provide a luminaire extension and luminaire wiring. The final power hook-up and the actual luminaire shall be provided and installed by the Contractor. Luminaire heads shall be General Electric Evolve ERLH or approved equal.

9.14.41 Vehicle Detectors and Bluetooth Readers

Stopbar detection for designated phases shall be provided. The locations and type of detection shall be indicated in the plans.

Counting detectors, when explicitly called out in the plans, shall be provided for each approach lane of traffic according to the City's direction. When imbedded in the roadway, detectors shall be located 20 feet or more upstream of stopbar detectors, or 10 feet or more upstream of the closest water type pull box where no stopbar detector exists. See City of Castle Pines Standard Signal Details.

On all approaches with free-flow speeds of 40 to 45 mph and greater, advance detection for dilemma zone protection shall be provided. Site-specific conditions, such as grades or sight-distance obstructions, may also justify use of advance detection. The potential need for advance detection in these cases should be reviewed with the City.

Advance Detection Zones placement shall be in accordance with Table 9-11.

Table 9-11. Advance Detection Zone Placement

Posted Speed (mph)	Zone Placement (measured from back edge of crosswalk or stop bar) (feet)
25	100
30	150
35	205
40	235
45	270
50	300

When microwave or video detection is specified, a note shall be included on the signal plans that requires the Contractor to coordinate with the device manufacturer to determine placement and orientation of detection. Detection supplier's representative must be present for detection setup and initial operation.

9.14.42 Signal Power

1) The traffic signal design engineer (Engineer of Record) or the Contractor responsible for signal construction shall coordinate power source and meter location and requirements as part of the signal design. Coordination shall include determination of, and initial contact with, the appropriate power company, indication of the power source and meter location on the signal plans, and the power company's contact name and number. Meter location shall be within 75 feet of the vault or cabinet or home run pull box and on the cabinet corner unless otherwise approved.
2) In general, circuit breakers and power disconnects should be located internal to service meter assemblies and signal controller cabinets, and should not be readily accessible to the public.
3) Typically, the City inspector will be responsible for inspecting service installations and certifying acceptability to the utility company for hook-up. The City Public Works Department shall be responsible for all inspections from the point of connection of power to the inside of the cabinet out through the intersection.

9.14.43 Construction Requirements

9.14.43.1 Scope

This section describes general signal construction requirements for use in the City. Variances from these requirements require the City's written approval.

9.14.43.2 Inspections

1) For all City field inspections, the Contractor shall give at least 48 hours' prior notice to the City Public Works Department and the City Building Division for electrical inspections on the City's website. Inspections will normally be completed by City staff or the Contract Administrator.
2) The Contractor shall contact the City at least 48 hours prior to placing the pole foundations.
3) The Contractor shall notify the City at least 48 hours prior to standing the traffic signal poles.

9.14.43.3 Field Location

1) Prior to initiating the traffic signal design, the Contractor's Engineer of Record (or authorized representative) shall schedule and attend a field meeting with the City, or the authorized City personnel and the utility location company, to field locate the signal pole foundation locations and determine the appropriate mast arm lengths.
2) All poles, power meters, control cabinets, and pull boxes shall be field located by the City or its designee(s). The Contractor shall contact the City 2 days prior to field location.

9.14.43.4 Signal Turn-on

1) Signal heads installed on mast arms, span wires, or poles at new signal locations that are not ready for actual electrical operation shall be bagged with orange plastic.
2) Traffic signal construction and all associated work, including operational luminaries, shall be 100% complete prior to flashing operation.
3) Immediately prior to signal turn-on, signals shall be flashed from 2 to 5 days, with the exact duration of flashing determined by the City. Mondays, Fridays, and holidays are excluded for start of flash days.
4) The Contractor's Project Manager, IMSA Level II Traffic Signal Bench Technician/ Signal Technician (BB Certification), Opticom emitter, Foreman (BE Certification), and a bucket truck are required at all signal turn-ons.
5) The Contractor must contact the City or the City's authorized personnel 48 hours prior to signal flash. At the scheduled signal flash, the date and time for full operation will be determined. Failure to contact these parties will result in the forfeiture of retainage or liquidated damages equal to retainage.

9.14.43.5 Equipment Condition

1) The Contractor shall verify that the traffic signal cabinet is in good condition upon delivery. Any surface areas damaged during the handling and installation shall be repaired immediately per the manufacturer's specifications.
2) Prior to the installation of the mast arms and poles, the Contractor shall wipe them clean. Following installation of the poles, the Contractor, shall use factory-supplied paint to touch up nicks and abrasions (refer to Section 9.14.33).

9.14.43.6 Cabinet Base Installation

At the cabinet base location, the Contractor shall install gravel in the excavation for the conduit, set the cabinet base, and fill the riser portion of the base with gravel.

9.14.44 Payment Basis

The accepted quantities will be paid for at the contract unit price for each of the pay items listed in Table 9-12 that appear in the bid schedule.

Table 9-12. Payment Schedule

Pay Item	Unit
Removal of Traffic Signal Equipment	LS
Reset Traffic Signal Equipment	LS
PVC Conduit 2-inch Trenched	LF

Pay Item	Unit
PVC Conduit 2-inch Bored	LF
PVC Conduit 3-inch Bored	LF
Common Trench	LF
Common Boring	LF
PVC Conduit 2-inch (within common boring, trench, or sleeve)	LF
PVC Conduit 3-inch (within common boring, trench, or sleeve)	LF
Traffic Signal Light Pole, xx-foot mast arm without luminaire (Install Only)	EA
Traffic Signal Pole, xx-foot mast arm (Install Only)	EA
Traffic Signal Pedestal Pole (Install Only)	EA
Street Name Signs (Aluminum) (Illuminated)	EA
Sign Panel (Class I)	EA
Sign Panel (Class II)	EA
Traffic Signal Head, 3-section, 12-inch lenses	EA
Traffic Signal Head, 3-section, 12-inch lenses “Arrow”	EA
Traffic Signal Head, 5-section, 12-inch lenses “Vertical”	EA
Traffic Signal Head, 5-section, 12-inch lenses “Dog House”	EA
Pedestrian Head (16-inch) (Countdown)	EA
Pedestrian Push Buttons	EA
Intersection Detection System (Camera)	LS
Microwave Radar Vehicle Detection System	LS
Traffic Signal Controller Cabinet (332D)(with Dual Input File and AUX output file)	EA
Traffic Signal Controller (2070L)	EA
Uninterrupted Power Source	EA
Fiber Optic Cable	LF
Fiber Termination	EA
Network switch, power supply and rack mount kit	EA
Test Fiber Optic Cable	LS
Pull Box (Type I)	LS
Pull Box (Type II)	EA
Pull Box (Type III)	EA
Pull Box (Special)	EA
Emergency Preemption Card	EA

Pay Item	Unit
Emergency Preemption Detector	EA
Radio Communications System	LS
Furnish and Install Electrical Service Connection	LS
Traffic Control, Mobilization, and Start-up	LS
City of Castle Pines Permit	LS
Concrete Sidewalk	SY
Remove Striping and/or surface preparation	LF
10-foot-by-2-foot Crosswalks	LF
Arrows	EA
Onlys	EA
Striping (Double Yellow)	LF
Striping (White)	LF

Notes:

EA = each
LF = linear foot
LS = lump sum
SY =square yard

9.14.45 Pay Item Notes and Clarifications

1) Removal pay items shall consist of items in the pay item list or items specifically identified on the plans or in writing by the City. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included items prior to bidding.

2) Removal of traffic signal equipment items shall consist of items in the pay item list or as specifically identified in the plans or in the project special provisions or at a minimum as identified in Section 9.11. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included items prior to bidding.

3) Reset pay items shall consist of items in the pay item list or items specifically identified on the plans or in writing by the City. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included items prior to bidding.

4) Reset of traffic signal equipment items shall consist of items in the pay item list or as specifically identified in the plans or in the project special provisions or at a minimum as specified in Section 9.11. It shall be the Contractor's responsibility to assure that it has a full and complete understanding of included items prior to bidding.

5) Common trench is the trench itself not including conduit.

6) Common boring is the boring itself not including conduit.

7) Conduit shall include signal cable, elbows, pull wire, weatherheads, adaptors, condulets, saw cutting, excavation, backfill, jacking and drilling pits, removal of pavement, sidewalks, gutters, curbs and their replacement in kind to match existing grade and all work necessary to complete the item.

8) The cost of the traffic signal light pole/ mast arm, traffic signal pole/ mast arm, and the traffic signal pedestal pole shall include the cost of the concrete foundations and all items associated with the installation and construction of the foundations, unless the foundations are existing. Refer to the standard details for concrete foundation size requirements.

9) Microwave radar vehicle detection shall be paid for based on the detector system required to complete the item.

10) Fiber-optic cable installation shall include all labor and materials required to install the cable, including, but not limited to, the following items:

- Required splice kits, splicing tools, ancillary hardware and labor to accomplish the splices
- Required patch cords
- Required fan-out kit tools, ancillary hardware, and labor to accomplish the fan-out

11) Fiber-optic termination shall include all labor and materials required to terminate the interconnect cable and make a complete and operational system, including, but not limited to, the following:

- Required termination enclosures (including specified features), connectors, adaptors, jumpers, pigtails, ancillary hardware, and labor required to accomplish the termination
- Other work necessary to complete the item

12) Test Fiber-Optic Cable – Lump sum includes the complete end-to-end OTDR test on all fiber strands (before and after installation), including document submission and the complete end-to-end optical power meter test on all fiber strands, including document submission.

13) Furnish and Install Electrical Service Connection – Lump sum. This information shall be clarified on the plans.

14) Striping Material (Crosswalks, Arrows, Onlys, Lines) – Striping materials shall be as determined by the City Public Works Department and indicated on the plans.

Chapter 10 - Pavement Design and Technical Criteria

10.1 General

This chapter provides the basic criteria and design procedures for roadway pavements. In the City of Castle Pines, Roadway Pavement Designs are required prior to placing pavement base course or curb and gutter. Recommended design methodologies for asphalt (referred to as Hot Bituminous Pavement, Existing Bituminous Pavement, or Asphalt Paving Material) and Portland cement concrete are addressed and follow both Metropolitan Government Pavement Engineers Council (MGPEC) and the American Association of State Highway and Transportation Officials' (AASHTO) *Guide for Design of Pavement Structures*. Some criteria modifications have been made in the following design procedures. In case of discrepancy, the most stringent criteria shall take precedence as determined by the City. Contact the City Public Works Department if questions or clarifications regarding criteria.

10.2 Pavement Design Report Submittal Options

The final pavement design shall be performed after the over-lot grading has been completed and the wet utilities have been installed, if applicable. A Right-of-Way Permit must be obtained prior to taking soil samples for a pavement design. The Applicant shall obtain Permits only after the final construction plans, which include the pavement design, are approved by the City. The submittal for pavement design approval must be in accordance with these Roadway Standards.

If a street is to be built in phases (that is, the center two lanes are built first, then at some later date, more lanes are added), a new Pavement Design investigation and report for the additional lanes may be required if it has been at least 2 years since the original design was approved. The City will decide whether a new Pavement Design will be required. All approved pavement designs shall be valid for a period of at least 2 years.

10.3 Preliminary Pavement Design Reports

For all City land development approvals that involve a subdivision improvement agreement for roadway construction, upon the request by the City Public Works Department, the Applicant must provide, at a minimum, a preliminary subgrade investigation and preliminary Pavement Design report that recommends a typical pavement structural section based on the known site soil conditions, Table 10-7, and the applicable Traffic Impact Study requirements in Chapter 6 of these Roadway Standards. The preliminary reports shall use the equivalent single-axle loads (ESALs) of Table 10-2. This preliminary Pavement Design serves as a justification of the roadway improvement costs included in the subdivision improvements agreement but not for final pavement designs submittals. The preliminary Pavement Design should address the potential need for swell mitigation as discussed in Section 10.6.

A preliminary pavement design may be submitted with final construction plans. Table 10-1 provides a checklist for subgrade investigation and pavement design.

Table 10-1. Subgrade Investigation and Pavement Design Checklist

Soil consultant	OK REJECTED		
Subdivision	REVIEWED		
Filing Job No.	BY:		
STREET			
DATE	Yes	No	Comment
1. Vicinity map			
2. Drawings with boring locations and logs			
3. Drawing with estimated extent of soil types and ESAL			
4. Drawing with pavement alternatives			
5. Atterberg limits, gradation, % passing no. 200 sieve			
6. Soil classifications			
7. Composite samples: grouped at 250' maximum intervals			
8. For R-value testing – Dry density & moisture content for each sample – Expansion pressure for each sample – Exudation pressure – R-Value curve			
9. Design nomograph shown with soil support values and ESALs			
10. Strength coefficient used for asphalt, base course, etc.			
11. Design calculation shown for all phases of soil report			
12. Minimum pavement section met for proper classification			
13. Special problems (expansion, frost heave, groundwater) with design & construction problems			
14. Swell mitigation measures (if applicable)			
15. Swell mitigation map			
16. Import materials limitations			

10.4 Subgrade Investigation

10.4.1 Field Investigation

The field investigation shall consist of borings or other suitable methods of sampling subgrade soils to a depth of at least 5 feet below proposed subgrade elevation (10 feet below proposed subgrade on Arterial roadways), at a spacing of not more than 250 feet unless otherwise accepted by the City Public Works Department. Every fifth hole shall be 10 feet deep. At a minimum, every third hole should be placed in the area of the sanitary sewer or storm sewer trench backfills no closer than 2 feet from the top of pipe. Boring logs shall include the Standard Penetration Test number of blows per foot, percent moisture, and free water, and should show soil types encountered in the boring. If more than one soil type is encountered in the boring, they shall be logged and sampled separately. Samples shall be taken after over-lot grading is within a tenth of a foot of finished subgrade (based on the roadway profile); the sanitary sewer and waterline (including services) have been installed and trenches are compacted; and compaction testing is complete. All borings shall be sampled using a California-type sampler in accordance with the *AASHTO T 206: Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils*.

10.4.2 Classification Testing

Each subgrade sample shall be classified using the *AASHTO M 145 Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes* and the ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*. The classifications require results from the following tests:

15) *AASHTO T 11, Standard Method of Test for Materials Finer than No. 200 (75 µm) Sieve in Mineral Aggregate by Washing*

16) *AASHTO T 27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates*

17) *AASHTO T 89, Standard Method of Test for Determining the Liquid Limit of Soils*

18) *AASHTO T 90, Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils*

The water-soluble sulfate ion content shall be determined at a frequency of 1 test per 1,000 feet for AASHTO Type A-6 and A-7 soils. Testing shall be performed in accordance with *AASHTO T 290, Standard Method of Test for Determining Water-Soluble Sulfate Content in Soil* or CDOT CP-L 2103, *Determining the Sulfate Ion Content in Water or Water-Soluble Ion Content in Soil*

10.4.3 Soil Grouping

To facilitate subgrade support testing, soil samples collected during the field investigation can be combined to form soil groups. These groups shall be based on the AASHTO Classification, Group Index, and location within the area investigated. Groupings shall not consist of samples with different AASHTO Classifications (note that there may be more than one group within a given classification). Composite samples can be made by combining small, equal portions of each subgrade sample contained within the group and mixed to provide a uniform composite sample of the soil group. The maximum allowable difference in the subgrade sample group index will be 5 or less for the composite sample.

10.4.4 Subgrade Support Testing

Samples shall be tested to determine the subgrade support value using R-Value testing. The pavement shall be designed for the soil (or soil group) exhibiting the lowest subgrade support value. These values shall be used in the design of pavement sections in accordance with the procedures outlined in

Section 10.4. Tests shall be conducted in accordance with the procedure listed in Section 10.4.5, R-Value Tests.

10.4.5 R-Value Tests

R-Values tests shall be conducted in accordance with AASHTO T 190 *Standard Method of Test for Resistance R-Value and Expansion Pressure of Compacted Soils*. The R-Value shall be determined at 300 psi exudation pressure. The reported data shall consist of the following :

1) Dry density and moisture content for each sample
2) Expansion pressure for each sample
3) Exudation Pressure – corrected R-Value curve showing the R-Value at 300 psi

10.4.6 Swell Test

All soil groups, excluding A-1 through A-4, shall be tested to determine swell or settlement potential. Tests shall be run on the "California" samples in accordance with ASTM D 4546 at a surcharge of 200 psf. The swell tests shall be plotted and the percent swell or settlement and swell pressure (psf) shall be determined and reported. All swell tests shall be run only on undisturbed samples; remolded samples shall not be used. Test results that are suspected of being too high or too low for the soil type shall not be considered in the design of the pavement but shall be reported. Any deletion of data shall be justified in the report. If the swell is 2% or greater, the pavement design report must provide mitigation measures. Refer to Section 10.4.3.

10.5 Pavement Design Criteria

10.5.1 General

This section provides the factors to be used for the design of pavements of various roadway classifications.

10.5.2 Equivalent (18-kip) Single Axle Load

The pavement design procedure in this chapter provides for a 20-year service life, given that normal maintenance is provided to keep the roadway surface in an acceptable condition. ESALs are considered equivalent units based on 20-year design criteria and an 18-kip axle loading. ESAL criteria for each City roadway classification are given in Table 10-2.

If actual traffic counts are available, they shall be used to calculate ESALs in lieu of using Table 10-2. It is recommended that a Traffic Impact Study be performed.

Table 10-2. Minimum Equivalent (18-kip) Single-Axle Load

Classification	Class Modifier	ESAL Values[a]
Local	Residential	
	Serving < 80 D.U. All Others	60,000
	Commercial/Industrial [b]	75,000
		220,000
		750,000
Entry	Residential	75,000

Table 10-2. Minimum Equivalent (18-kip) Single-Axle Load

Classification	Class Modifier	ESAL Values[a]
Collector[b]	Residential Commercial/Industrial[b]	250,000 500,000 1,500,000
Arterial[b]	All	2,000,000

[a] Alternative ESAL values may be considered with justification provided by the Traffic Impact Study proposed land uses, and traffic analysis that defines a proportion of truck vehicles.

[b] ESAL values shall be calculated based on projected traffic uses. Minimum ESAL values are as prescribed in Table 10-2.

10.5.3 Design Serviceability

Design serviceability loss (ΔPSI) is determined by subtracting the terminal serviceability index (SI) at the end of the design period from the SI at initial construction. The SI at initial construction will normally fall in the range from 4.2 to 4.6 and generally can be assumed to be 4.5. The SI at the end of the design period is the worst-case allowable condition that the pavement may reach. Table 10-3 outlines the design serviceability loss (ΔPSI) and terminal serviceability index to be used.

Table 10-3. Design Serviceability Loss and Terminal Serviceability Index

Roadway Classification	(ΔPSI)	Terminal Serviceability Index
Arterials (Minor, Principal)	2.0	2.5
Collectors	2.0	2.5
Local: Residential	2.5	2.0
Local: Commercial/ Industrial	2.0	2.5

10.5.4 Functional Class and Reliability

The reliability level depends on the functional classification of the proposed roadway. The reliability factor used shall be 95% for all Arterials and shall be 90% for all Collectors and Local roads.

10.5.5 Resilient Modulus

The Resilient Modulus (M_R) can be measured directly from laboratory tests or obtained by using a correlation with R-Value. R-Value is determined by using AASHTO T 190 *Standard Method of Test for Resistance R-Value and Expansion Pressure of Compacted Soils*. The approximate value of M_R is determined by using the following equations:

$$S = [(R-5)/11.29]+3$$

$$M_R = 10[(S+18.72)/6.24]$$

Where:

M_R = resilient modulus (psi)
S = soil support value
R = R-Value obtained from AASHTO T 190 or from the Hveem Stabillometer

Designers should note that although the R-Value is used to gather input data for pavement design, the result of the R-Value test is not the M_R. It is recommended that documentation of the pavement design show that when the R-Value test is used, the M_R is an approximation from correlation formulas.

When the R-Value is reported as less than 5 or "unstable," there is no correlation to the M_R. When the reported R-Value is 5 or less or "unstable," the soil needs to be mitigated by an approved stabilization procedure or removal and replacement with approved materials in accordance with Section 10.4.3.

10.5.6 Flexible Pavement Design Factors

Table 10-4 outlines the design factors for flexible pavement. When subgrade stabilization is required, an R-Value of 5 shall be used to determine the Structural Number.

Table 10-4. Flexible Pavement Design Factors

Factor	Source
18-kip ESAL	Table 10-2
Reliability, R	90% Arterials and Collectors 85% Local Roads
Overall Deviation, So	0.44
Serviceability Loss, ΔPSI	Table 10-3
MR Value of the Subgrade	Soil profile report from laboratory and correlation equations
Structural Layer Coefficients (ai)	Table 10-6

10.5.7 Flexible Pavement Strength Coefficients

Table 10-6 contains the standard design strength coefficients for various pavement materials. These strength coefficients are based on materials designed in accordance with current City specifications.

10.5.8 Portland Cement Concrete Working Stress

The working stress (f_t) to be used in the design shall be 75% of the design modulus of rupture (flexural strength) of Portland cement concrete. The design modulus of rupture shall be 650 psi; therefore, the design working stress (f_t) shall be 485 psi.

10.5.9 Minimum Pavement Section

This paragraph provides the minimum acceptable pavement sections for public roadways in the City. These pavement thicknesses may be used for preliminary planning purposes or for estimating collateral requirements for subdivision improvement agreements. Final pavement designs must be based on actual subgrade support test results. Table 10-5 lists these minimum thicknesses for each roadway classification.

Table 10-5. Minimum Pavement Sections

Classification	ESALs	Composite Section		Treated Composite Section			Full-depth Sections	
		Asphalt (inches)	Aggregate Base Course (inches)	Asphalt (inches)	Cement-Treated Aggregate Base Course (inches)	Lime-treated Subgrade (inches)	Full-depth Asphalt (inches)	Portland Cement Concrete (inches)
Local								
Residential	(Table 10-2)	4	6	4	5	6	N/A	6
Commercial	220,000	4	6	4	5	6	N/A	7
Industrial	750,000	5	8	4	8	6	7	9
Collector								
Residential	250,000	5	6	4	6	6	N/A	7
Commercial	500,000	5	8	4	8	12	7	7
Industrial	1,500,000	6	10	5	9	12	8	9
Arterial	2,000,000	6	10	5	9	12	8	9

Notes:

Pavement Sections do not include swell mitigation.

Proposed Treated Composite Sections to increase Strength Coefficients in Table 10.6 shall require approval prior to submittal of Pavement Designs.

Lime Treated Subgrade may be used with a Composite Section or a Treated Composite Section or not at all.

10.5.10 Flexible Pavement Strength Coefficients

Table 10-6 contains the standard design coefficients for various pavement materials. Nonstandard design coefficients may be used only if approved in advance by the City Public Works Department.

Table 10.6. Strength Coefficients

Pavement Structure Component [a]	Strength Coefficients	(Limiting Test Criteria)
Conventional Materials		
Plant Mix Seal Coat	0.25	
Hot Bituminous Pavement	0.44	
Existing Bituminous Pavement	0.30 0.24	(9–15 yr.) (>15 yr.)
Aggregate Base Course	0.12	(R 78+)
Existing Aggregate Base Course	0.10	(R 69+)
Granular Subbase Course	0.07	(R 50+)
Treated Materials[b]	Verification of testing required for items listed below	
Cement-Treated Aggregate Base	0.23	(7-day, 640–1,000 psi)
Lime-Treated Subgrade	0.14	(7-day, 160 psi, PI <6)

[a] A combination of one or more of the following courses placed on a subgrade to support the traffic load and distribute it to the roadbed.

- Subbase. The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course, surface course, or both.
- Base Course. The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.
- Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "Wearing Course."

[b] Proposed Treated Materials shall require approval prior to approval of Pavement Designs.

Note:

PI = plasticity index

10.5.11 Trench Drains

Trench drains are required along both sides of all public Collectors and Arterials with curb and gutter. All new local roads constructed on A-6 or A-7 soils that have a swell potential greater than 2% shall include trench drains if required in the pavement design. A City of Castle Pines Notice of Change will be required to add the trench drain on local roads. Trench drains shall be placed along both sides of the pavement and wherever else it is determined to be necessary. The purpose of the subsurface piping system is to provide drainage for the street subbase and to create an outlet for irrigation water. Trench drains shall discharge to the storm sewer system or to the surface drainage system upon approval from the City. No trench drains shall connect to the sanitary sewer system.

Minimum size of trench drains serving more than one lot shall be 4 inches in diameter. Typical trench drain details are provided in Appendix A.

10.5.12 Preliminary Planning Pavement Designs

Table 10-7 presents pavements designed for each functional class of road with typical worst-case subgrade conditions. These sections may be used in combination with a subgrade investigation report to begin construction with the City's approval. If swell mitigation is required, as defined in Section 10.6, or as identified during the preliminary Pavement Design investigation, it is in addition to these preliminary planning Pavement Design sections.

Table 10-7. Preliminary Planning Design Pavement Sections

Classification	ESALs	Composite Section		Treated Composite Section			Full-depth Sections	
		Asphalt (inches)	Aggregate Base Course (inches)	Treated Subgrade (inches)	Asphalt (inches)	Aggregate Base Course (inches)	Full-depth Asphalt (inches)	Portland Cement Concrete (inches)
Local								
Residential	(Table 10-2)	5	8	5	6	6	N/A	6
Commercial	220,000	5	8	5	6	6	N/A	7
Industrial	750,000	6	10	5	10	6	8	10
Collector								
Residential	250,000	6	8	5	8	6	N/A	8
Commercial	500,000	6	10	5	10	12	8	9
Industrial	1,500,000	7	12	6	12	12	9	10
Arterial	2,000,000	7	12	6	12	12	9	10

Notes:

Pavement Sections do not include swell mitigation.

Proposed Treated Composite Sections to increase Strength Coefficients in Table 10-6 shall require approval prior to submittal of Pavement Designs.

Lime-treated Subgrade may be used with a Composite Section or a Treated Composite Section or not at all.

10.6 Pavement Design Procedure

10.6.1 Flexible Pavements

The following procedure uses nomographs to determine the Structural Number (SN) and then an equation to determine the design thickness of the pavement structure. The use of this procedure to determine the pavement structure is required. Additionally, various software programs are available that are based on the AASHTO design procedure and may be used. The use of these programs is encouraged in conjunction with the use of the nomographs. The software programs should be based on the AASHTO Design Procedure. The nomographs are to be used to verify the design produced by any software programs.

The following procedure should be used in determining the SN of the pavement being designed:

1) Select the level of Reliability required in Table 10-4. Enter the nomograph, Figure 10.1, at the left scale using the Reliability level value. Connect the Reliability component with a Standard Deviation value (0.44). Extend this line to the first turning line (TL).
2) From the TL intercept, draw a line through the appropriate value for estimated traffic, the 18-kip ESAL. Extend the line to the second TL.
3) From this TL intercept, draw a line through the appropriate soil support value (roadbed soil M_R) and extend it to left edge of the Design Serviceability Loss portion of the nomograph.
4) Plot the horizontal line intercepting the selected psi value from Table 10-3. From this turning point, plot a vertical line down to the resultant Design SN.
5) Once the SN has been determined, the design thicknesses of the pavement structure can be determined by the general equation:

   $SN = a_1D_1 + a_2D_2 + a_3D_3 + ...$

   where

   a_1 = Asphalt strength coefficient a_2, a_3, a_n. = strength coefficients of additional pavement components
   D_1 = thickness of asphalt (inches) D_2, D_3, D_n = thickness of additional pavement component sections
6) The strength coefficients for various components of the pavement structure are given in Table 10-6.
7) The component thickness selected must meet two conditions:
   a) Total hot bituminous pavement thickness selected cannot be less than the minimum specified in Table 10-5 for the roadway classification.
   b) The base course thickness selected cannot exceed 2.5 times the hot bituminous pavement thickness selected.
8) The design must reference any mitigation measures required when the subgrade contains swelling soils as defined in Section 10.4.3.

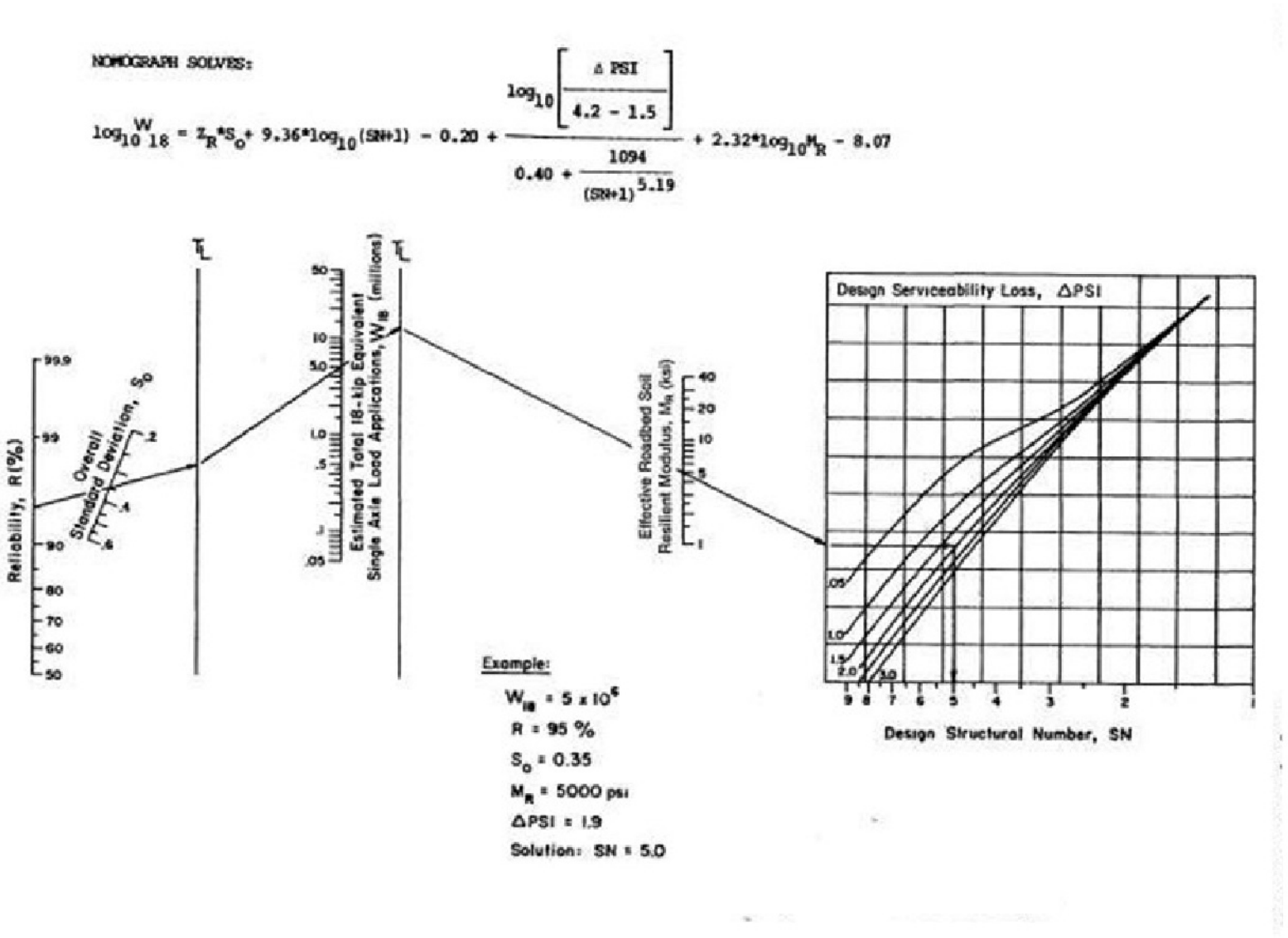


Figure 10-1. Nomograph for Asphalt Pavement

10.6.2 Rigid Pavement

The following procedure uses nomographs to determine the SN and then an equation to determine the design thickness of the pavement structure. The use of this procedure to determine the pavement structure is required. Additionally, various software programs are available that are based on the AASHTO design procedure and may be used. The use of these programs is encouraged in conjunction with the use of the nomographs. The software should be based on the AASHTO Design Procedure. The nomographs are to be used to verify the design produced by any software programs.

Use the following procedure to obtain required thickness:

1) Determine the Effective Modulus of Subgrade Reaction, K(pci) from Table 10-9 and Figure 10-4. Enter the nomograph, Figure 10-2 (segment 1), at the bottom of the Effective Modulus of Subgrade Reaction, K(pci) graph. Connect the K(pci) value with the Concrete Elastic Modulus (E_C) referenced in Table 10-8. Extend the line to the right edge of the graph.
2) Extend the line through the Mean Concrete Modulus of Rupture, S'c (pci) referenced in Table 10-8 to the first TL. Determine the Terminal Serviceability Index of the roadway (Table 10-3).
3) From the TL intercept, draw a line through the Load Transfer Coefficient, (J) referenced in Table 10-8 to the second TL.
4) From the TL intercept, draw a line through the Drainage Coefficient (Cd) referenced in Table 10-8 to the Match Line.
5) Extend the line from the Match Line (segment 2) through the Design Serviceability Loss, referenced in Table 10-3 to the left edge of the Design Slab Thickness Nomograph.
6) Select the Level of Reliability from Table 10-8. Enter the nomograph Figure 10-3 (segment 2) at the bottom of the Reliability line. Connect the Reliability component with the Overall Standard Deviation (So) from Table 10-8. Extend this line to the TL.
7) From the TL intercept, draw a line through the appropriate ESAL applications to the bottom edge of the Design Slab Thickness nomograph. Extend lines from the left and bottom of the Design Slab Thickness nomograph to intercept at the appropriate Design Slab Thickness, D (inches).
8) The design must reference any mitigation measures required when the subgrade contains swelling soils as defined in Section 10.4.3.

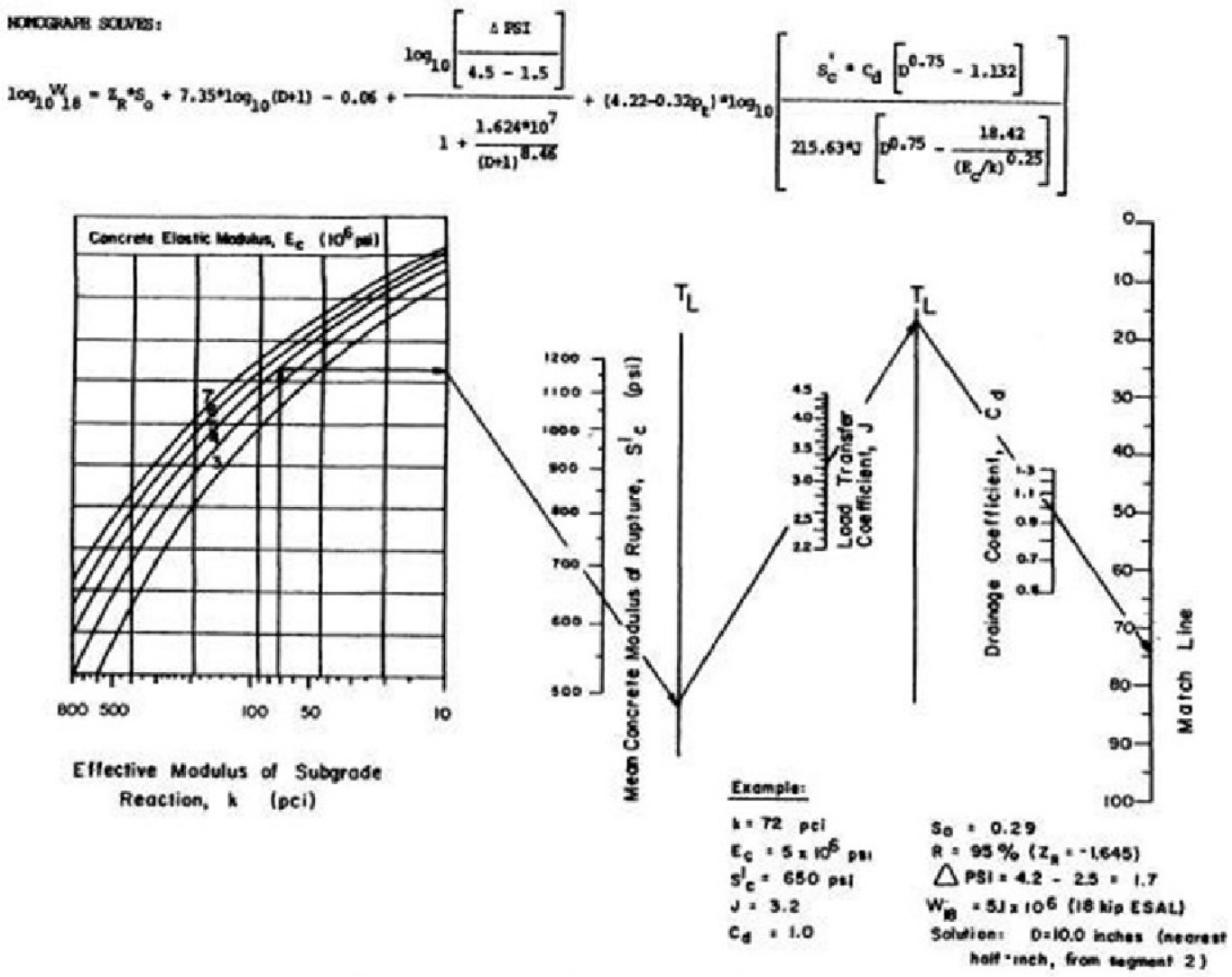


Figure 10-2. Nomograph for Rigid Pavement Design (Segment 1)

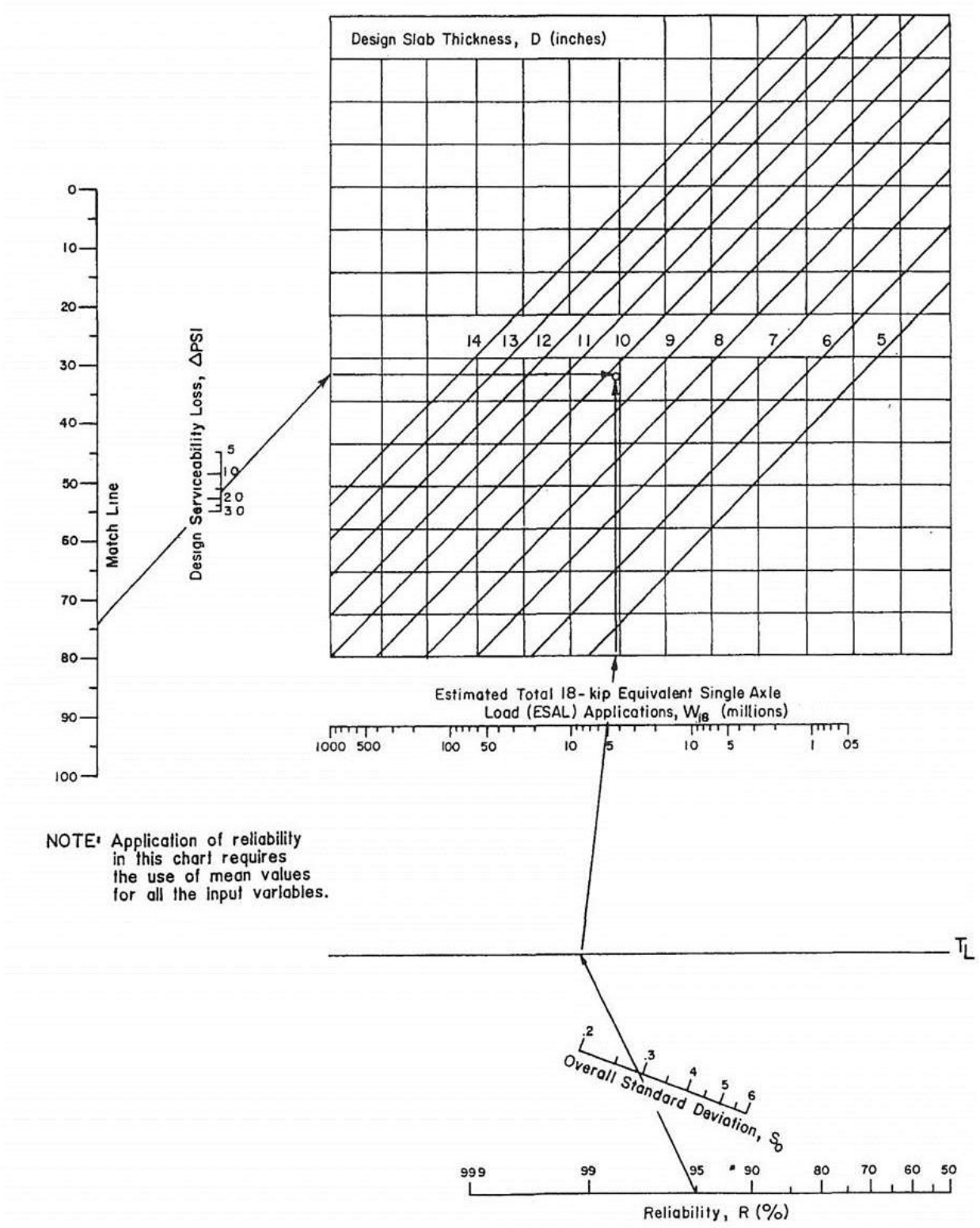


Figure 10-3. Nomograph for Rigid Pavement Design (Segment 2)

If software is used to verify the design, it will require additional input. The following table and figures are to be used to determine the additional input required by software programs. If software is used to determine the design thickness of the pavement, it is to be verified using the nomographs in this section.

Table 10-8. Rigid Pavement Design Factors

Factor	Source
18-kip ESAL	Table 10-2
Reliability, R	95% Arterials 90% Collectors and Local Roads
Overall Deviation, So	0.44
Serviceability Loss, Δ PSI	Table 10-3
Modulus of Subgrade Reaction, k	Determined in Section 10.6.2
Modulus of Rupture, S'c	650 psi
Modulus of Elasticity, Ec	3,400,000 psi
Drainage Coefficient, Cd	1.0
Load Transfer Coefficient (J)	If monolithic or tied curb and gutter are placed on both sides of the pavement, use 2.7; otherwise, use 4.2.

The Modulus of Subgrade Reaction, k, shall be determined from Table 10-9 and Figure 10-4. Table 10-9 lists k-values for soils classified as A-1 through A-7. Figure 10-4 is used with the degree of saturation to determine the k-value for soils classified as A4 through A-7.

Table 10.9 Modulus of Subgrade Reaction, K, for A-1 to A-7 Soils

AASHTO Class	Description	Unified Class	Dry Density Natural Condition	CBR (Percent)	K-Value (psi/in)
Coarse-Grained Soils:					
A-1-a, well graded	Gravel	GW, GP	125 – 140	60 – 80	300 – 450
A-1-b, poorly graded			120 – 130	35 – 60	300 – 400
A-1-b	Coarse Sand	SW	110 – 130	20 – 40	200 – 400
A-3	Fine Sand	SP	105 – 120	15 – 25	150 – 300
A-2 Soils (Granular Materials with High Fines):					
A-2-4, gravelly	Silty Gravel	GM	130 –145	40 – 80	300 – 500
A-2-5, gravelly	Silty Sandy Gravel				
A-2-4, sandy	Silty Sand	SM	120 –135	20 – 40	300 – 400
A-2-5, sandy	Silty Gravelly Sand				
A-2-6, gravelly	Clayey Gravel	GC	120 –140	20 – 40	200 – 450
A-2-7, gravelly	Clayey Sandy Gravel				
A-2-6, sandy	Clayey Sand	SC	105 -130	10 – 20	150 – 350
A-2-7, sandy	Clayey Gravelly Sand				

Table 10.9 Modulus of Subgrade Reaction, K, for A-1 to A-7 Soils

AASHTO Class	Description	Unified Class	Dry Density Natural Condition	CBR (Percent)	K-Value (psi/in)
Fine-Grained Soils:					
A-4	Silt	ML, OL	90 – 105	4 – 8	25 – 165[a]
	Silt/Sand/Gravel Mixture		100 – 125	5 – 15	40 – 220[a]
A-5	Poorly Graded Silt	MH	80 – 100	4 – 8	25 – 190[a]
A-6	Plastic Clay	CL	100 – 125	5 – 15	25 – 255[a]
A-7-5	Moderately Plastic Elastic Clay	CL, OL	90 – 125	4 – 15	25 – 215[a]
A-7-6	Highly Plastic Elastic Clay	CH, OH	80 – 110	3 – 5	40 – 220[a]

[a] K-value of fine-grained soil depends highly on degree of saturation. Refer to Figure 10-4.

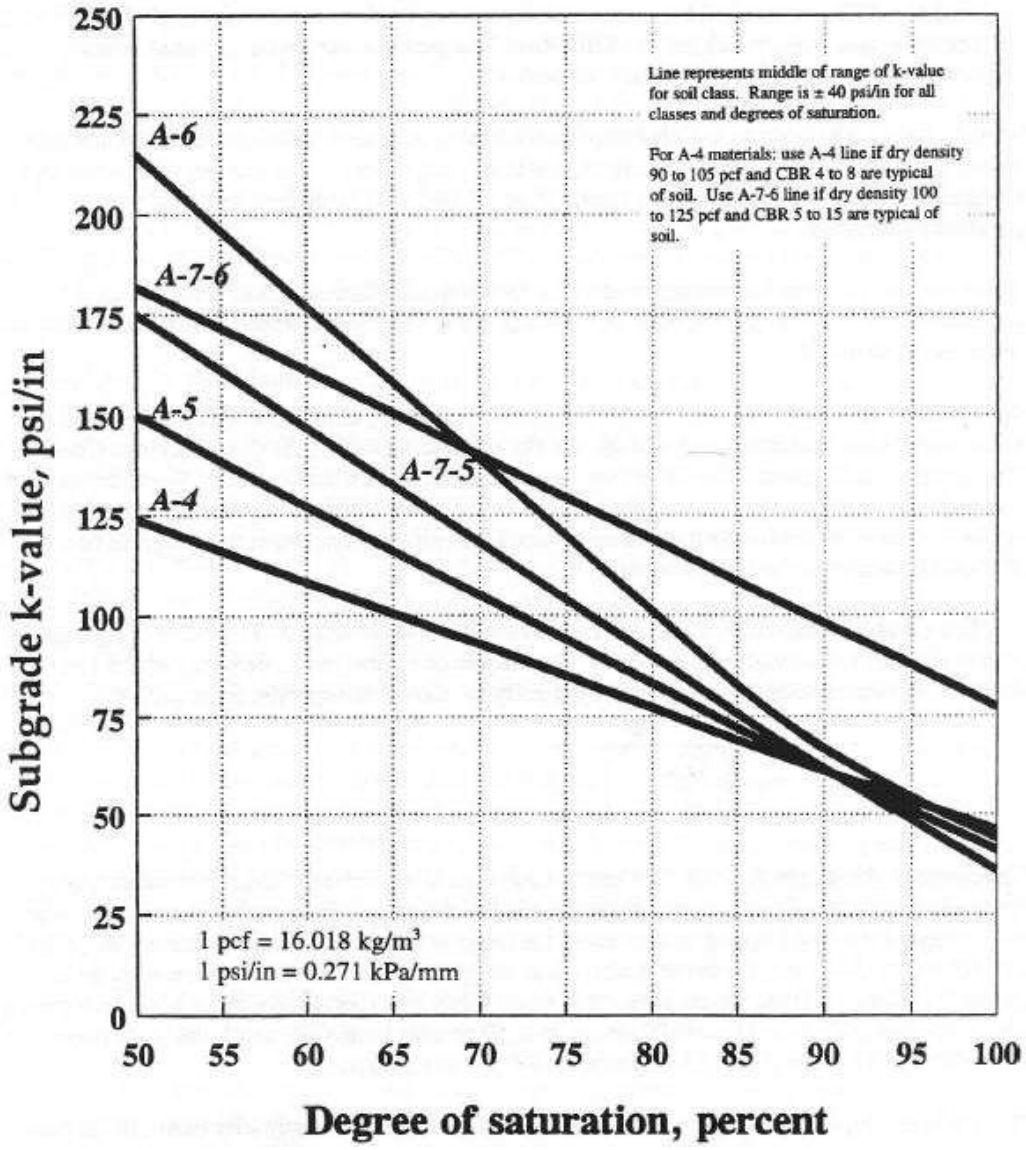


Figure 10-4. Modulus of Subgrade Reaction, K, for A-4 through A-7 Soils, Using Degree of Saturation

10.6.3 Subgrade Stabilization

The purpose of this section is to provide a zone of low-swelling, strain-absorbing material between the expansive subgrade and the pavement section. This specification shall be applied to achieve a stabilized paving platform without structural benefit to the pavement design. It is solely to address subgrade soils with an R-value of 5 or less or a subgrade material with swells of 2% or greater. The City requires that for soils with an R-value of 5 or less or a subgrade material with swell over 2%, the top 12 inches be replaced with 12 inches of Class 6 Aggregate Base Course. At a minimum, the limits of mitigation shall be from intersection to intersection on a roadway. The mitigation shall extend to 1 foot beyond the back-of-curb (if detached walk or no walk), or 1 foot beyond to the back-of-walk (if attached or monolithic walk). Alternate methods of mitigation may be proposed and will be considered on a case-by-case basis but must address the potential for soil remixing for utility installation by properly phasing construction to avoid remixing, or mitigation to a depth great enough that utilities installed after mitigation do not breach the mitigated zone.

The Design Report must reference mitigation measures when the reported R-value is 5 or less or is "unstable." These soils will need to be mitigated by an approved stabilization procedure or removed and replaced with an approved material.

1) Mitigation measures are required when the subgrade contains swelling soils (swell potential greater than or equal to 2.0% under 200 psf surcharge pressures at 95% standard compaction from a swell test run on undisturbed samples in accordance with ASTM D 4546). Moisture treatment and reconditioning is not an approved mitigation procedure. Mitigation shall include over excavation and replacement of the swelling soil with an A-2 to A-6 soil group with less than 2% swell. The over excavation shall be a minimum of 3 feet below the bottom of the approved pavement section. Upon removal of the 3 feet of material, the existing surface shall be scarified and reconditioned to a depth of 8 inches. The reconditioning shall be moisture treated and compacted according to these Specifications.
2) An option is to remove the swelling soil to a depth of 1 foot below the bottom of the pavement section, then replace the excavated materials with 1 foot of Class 6 Road Base. If the road base option is used, this may require the use of an approved geotextile fabric between the native material and the Class 6 Road Base. Upon removal of the 1 foot of material, the existing surface shall be scarified and reconditioned to a depth of 8 inches. The reconditioning shall be moisture treated and compacted according to these Specifications.
3) Other methods of swell mitigation could include the use of lime or Portland cement. Methods of mitigation to be used are subject to approval by the City Public Works Department. The submittal of an alternative for swell mitigation as described previously should include the requirements associated with the scarification and reconditioning of the subgrade below the proposed mitigation treatment.

Figure 10-5, Lime/ Cement Stabilization Flow Chart, provides a good estimate of whether lime or cement is applicable for a certain soil type, depending on gradation and PI to a depth of 1 foot below the bottom of the pavement section.

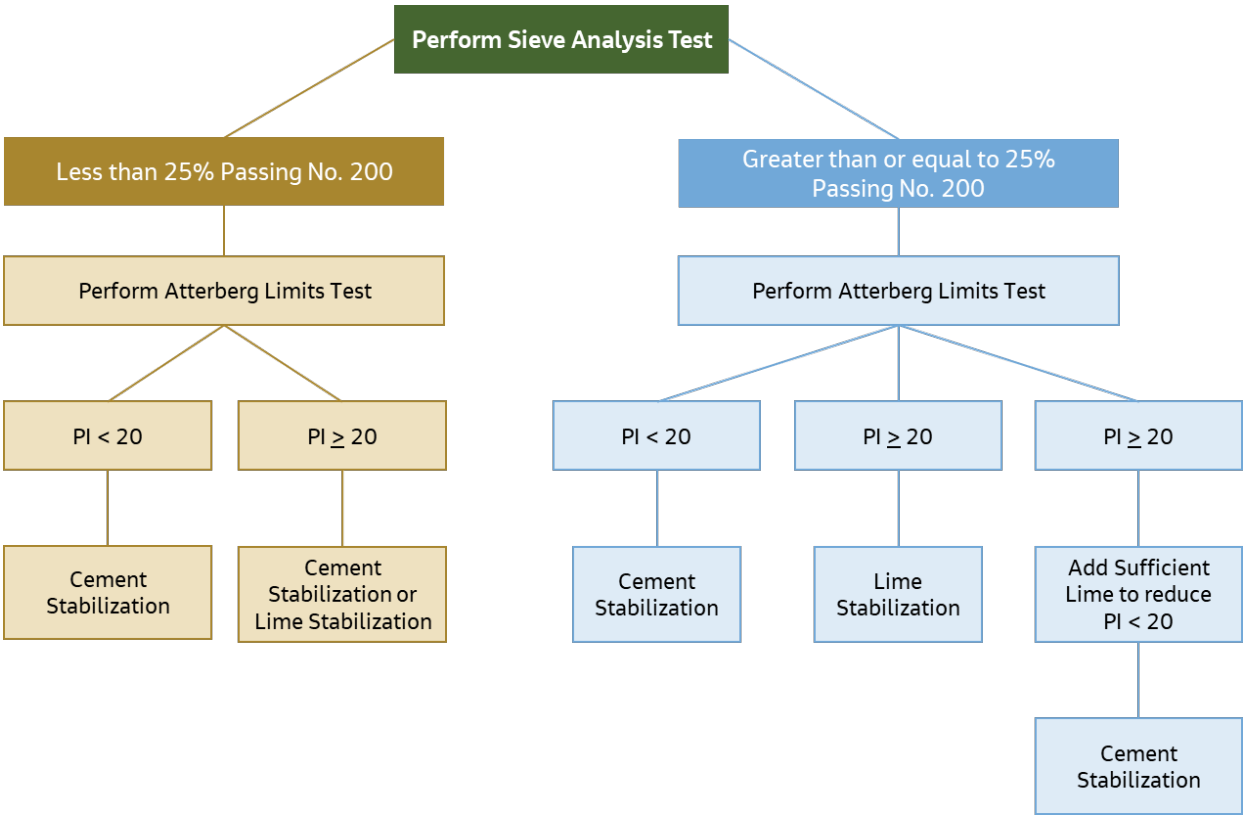


Figure 10-5. Lime/Cement Stabilization Flow Chart

Design reports recommending permeable layers, such as untreated aggregate base course in the pavement system, must present the measures to be used tocreate adequate drainage of such layers and to maintain segregation of the layers from the swelling soils. Trench drains are required for all pavements constructed on A-6 or A-7 soils in accordance with Section 10.3.11.

10.7 Material Specifications

10.7.1 General

The specifications presented in this section are performance oriented. The City's objective in setting forth these specifications is to achieve an acceptable quality pavement structure. Asphalt and concrete pavement laboratory mix designs must be approved every 2 years by the City Public Works Department. All sources for the mined or manufactured materials used in mix designs must also be approved every 2 years by the City Public Works Department as having met the appropriate materials performance specifications. This approval is a condition of using those material sources for public improvement construction. For the purpose of these Roadway Standards, public improvements are all roadway improvements, sidewalks, curbs and gutters, appurtenant drainage basins or structures, storm sewers and their access ways, other public works within City rights-of-way, and City-mandated stormwater detention structures built on private property and maintained by the property owner(s).

10.7.2 Procedure for Material Source Approval

Material suppliers for any City public improvements shall supply written certified documentation along with material test results. The certified documentation must be stamped and signed by a PE licensed in the State of Colorado. The material testing must be performed by an AASHTO-accredited laboratory. The

documentation and material test results shall be submitted yearly by April 15th or a minimum of 14 days prior to construction and may include the following:

1) Material type, source, and location being tested to meet City specifications
2) Test procedures employed
3) Supplier's manufacturing, mining, or treating process by which the tested materials were processed
4) Material test results
5) A signed statement by the material supplier that the materials meet City specifications

10.7.3 Approval Conditions

10.7.3.1 Conformity to the Contract

Materials used in City public improvements will be sampled randomly and tested with the applicable procedures to verify compliance with material specifications. Additional samples may be selected and tested at the City's discretion. These tests are in addition to the requirements of Chapter 12.

Any and all material used to construct City public improvements that is not from a certified source, or that is from a certified source and fails one or more random material tests, may be subject to complete removal and replacement as a condition of City acceptance of that public improvement. Additional tests will be required to confirm the existence and extent of the sub-standard material prior to the initiation of remedial action. The extent of the material to be removed will be at the discretion of the City Public Works Department.

10.7.4 Use of Materials Not Listed in Section 10.5.5

Materials in this section and provided with a set of specifications are those deemed by the City to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials, such as manufactured paints and coatings, bonding agents, sealers, gaskets, and insulating materials, should comply with specifications for the appropriate material employed. Alternative materials for construction may be proposed for use. Decisions on acceptability of alternative materials will be made by the City's Public Works Director.

10.7.5 Material Specifications

10.7.5.1 Asphalt

Asphalt material shall conform to the MGPEC Asphalt Pavement Materials Specification. Alternate mix designs may be submitted to the City for review and approval.

10.7.5.2 Portland Concrete Pavement

Portland Cement Concrete Materials shall conform to the MGPEC Portland Cement Concrete Materials Specification. Alternate mix designs may be submitted to the City for review and approval.

10.7.5.3 Aggregate Base Course

Aggregate Base Course shall conform to the MGPEC Aggregate Base Course Materials Specification.

10.8 Subgrade Investigation and Pavement Design Report

The report shall be prepared by, or under the supervision of, and signed by a licensed PE registered in the State of Colorado and shall include the following information:

1) Vicinity map to locate the investigated area
2) Scaled drawings showing the location of borings
3) Scaled drawings showing the estimated extent of subgrade soil types and ESAL for each street
4) Pavement design alternatives for each street on a scaled drawing
5) Tabular listing of sample designation, sample depth, Group Number, Liquid Limit, Plasticity Index, percent passing the No. 200 sieve, AASHTO Classification, Group Index and soil description
6) R-value test results of each soil type used in the design
7) Pavement design nomographs properly drawn to show Soil Support – ESAL, SN
8) Design calculations
9) Software pavement design summary report
10) A discussion regarding potential subgrade soil problems, including, but not limited to, the following:
    a) Heave or settlement prone soils
    b) Frost susceptible soils
    c) Ground water
    d) Drainage considerations (surface and subsurface)
    e) Cold weather construction (if appropriate)
    f) Other factors or properties that could affect the design or performance of the pavement system

Chapter 11 - Permits

11.1 General

This chapter pertains to Public Works Permits required for any and all work occurring in the City's public rights-of-way and any work affecting public infrastructure. Contractors, public utility agencies, and property owners installing public or private improvements or storing materials or equipment within any public right-of-way or City-owned easements must obtain the required Permit(s) prior to commencing the work. The following Permits may be required prior to performing certain described activities in the public right-of-way and City-owned easements. The Applicant/ Contractor are responsible for obtaining the necessary Permits and associated requirements prior to any work in the right-of-way.

The electronic application for such Permits can be found the City's webpage: https://www.castlepinesco.gov/.

11.1.1 Right-of-Way Permits

All work in public rights-of-way and easements must be permitted in accordance with the criteria outlined here. It is unlawful for any person to perform work within a City public right-of-way without first obtaining a valid Permit from the City. Any person violating this requirement may be subject to a stop work order and other subsequent penalties set forth in the Castle Pines Municipal Code.

The Right-of-Way Permit governs the construction, removal, repair, or maintenance of utilities, cable TV, signs, and other facilities in the public right-of-way. This Permit also governs the installation or replacement of City-maintained public improvements, including sidewalk, curb and gutter; roadway subbase, wearing surface, drainage and flood control structures, piping, channels, signs, and traffic signals; and the construction and maintenance of utility mains or services. The Right-of-Way Permit governs new access points from private property to City streets and roadways.

11.1.2 Uses for Right-of-Way Permit and other Permit Types

A Right-of-Way Permit is required prior to beginning any repair or modification of existing or future public infrastructure or private improvements within the public right-of-way. It is also used to authorize the construction of minor public or private improvements and repairs that do not require a separate review and acceptance of public improvement construction plans, but instead are shown on an approved site plan. The Right-of-Way Permit also applies to additional types of work, including, but not limited to, traffic control, excavation, and aerial work.

11.1.2.1 Grading, Erosion and Sediment Control Permit (GESC Permit)

Earthwork (excavation, grading, clearing, grubbing, or filling) on private or public property within the City of Castle Pinesis governed by the City. A Permit is required for most earthwork construction on private property so that drainage from one property to the next is managed as designed. Any grading project over 1 acre is required to apply for a grading permit. Other properties less than an acre may require a low impact grading Permit depending on the type of construction proposed.

- The fee for this Permit shall be as established by the Municipal Code.
- The GESC Permit is required for any Contractor to begin over-lot grading, excavation, clearing, and grubbing within a particular development or project before work begins and sufficient surety is provided to the City Public Works Department.

- Refer to the City's GESC manual on the City's webpage for the requirements of this Permit and policies. https://www.castlepinesco.gov/.

11.1.2.2 Temporary Water Service Permits (Construction Water)

To service construction projects requiring the use of water, the Applicant must contact the appropriate Water and Sanitation District. Although the water and sanitary sewer systems are not owned or solely permitted through the City, Right-of-Way Permits are required for inspection of backfill and surfacing procedure in the right-of-way.

11.1.2.3 Overweight Vehicles

The City analyzes any necessary overweight hauling and will limit access to certain streets depending on the weight of vehicles. This analysis will occur in the evaluation of the Right-of-Way Permit Application.

11.1.2.4 State and Federal Permits

The construction of public infrastructure and land development projects at times require Permits from the state or federal agencies, including, but not limited to the following:

- Construction Stormwater or Dewatering discharges
- Stormwater Management plans
- Section 404 Permits for impacts to wetlands or waterways
- Air Emission Permit from Colorado Department of Public Health and Environment
- Other Permits from CDOT

The Owner/Developer should anticipate discussions of these Permit requirements in the pre-application meeting to confirm compliance with the various state and federal agencies.

11.1.2.5 Other City Permits

This section does not address other City Permits required, such as Building Permits, Water and Sanitary District Permits, Special Use Permits, or Peddler's Licenses. Those Permits are addressed separately through the City.

11.2 Permit Standards and Conditions

11.2.1 General Requirements

The Applicant shall be responsible for the following requirements, which are relevant for the project:

- **Review and Acceptance of Submittals**. The application will be reviewed by the City Public Works Department. If additional information is required, the Applicant will be contacted and required to supply the necessary information. In the review, the City Public Works Department will verify that the Applicant has provided the applicable bond, license, traffic control plans, construction plans, insurance documents, and all required submittals. The City Public Works Department will not review or process any incomplete applications for Permits. Permit reviews may require 10 working days after complete submittals.
- **Approval of Permit.** Permits are issued subject to the approval/acceptance of the City, state, or other governmental agencies having either joint supervision over the section of road, or authority to regulate land use by means of zoning or building regulations.
- **Issuance of a Permit**. The Permit is issued to the Applicant after all fees have been collected and applications and other applicable documents are submitted, reviewed, and accepted. This Permit

issuance is only temporary in nature, and any changes in schedule or work must be submitted in writing to the City Public Works Department for review and acceptance for the Permit to remain valid. Work cannot proceed after expiration of Permit without approval of the City Public Works Department.

- **Other Agency Approval.** Permit Applicants/Contractors are responsible for obtaining separate Permits or permission as may be required. Examples may be when work is proposed within the state highway, Utility District, or irrigation company rights-of-way or private property. The Permittee is responsible for coordinating with respective Agency(ies) to confirm their standards and specifications are met.
- **Easements.** It shall be the Applicant's responsibility to obtain required easements and approvals that may be required.
- **Submittals and Fees.** The Applicant shall pay all required fees, provide insurance, guarantee (if required), and provide appropriate plans, if necessary. The minimum fee for a Right-of-Way Permit is found in the Municipal Code. Any person or corporation commencing any work without prior valid written authorization, shall be required to pay a penalty fee. The penalty fee found can be found in the Municipal Code. The penalty fee includes the normal inspection fee.
- **Coordination of Utility Work.** The Applicant shall be responsible for coordinating any utility work, including relocation of the utilities (for example, power poles, transformers, and signals) with the appropriately responsible district or other third-party agency. These agencies may require their own Permit process.
- **Affected Area.** The Applicant is responsible for returning the areas affected by construction to equal or better condition prior to commencement of activity. The Applicant is responsible for repairing any damage to private or public property or other adjacent right-of-way that occurs during construction.
- **Not Transferable.** The Permit may not be transferable or assignable except as agreed to by the City. The Applicant may subcontract some of the work, and the subcontractor can work under the general contractor's permit.
- **Supplemental Permit.** The Contractor must receive a subsequent approval from the City Public Works Department for any work outside of the scope of the approved permit. It is the Applicant's responsibility to notify the City Public Works Department of the changes. The City Public Works Department will inform the Applicant whether they must apply for a supplemental Permit or a new Permit prior to undertaking the additional work. If the changes are significant, the City Public Works Department may require additional payment on the existing Permit for the additional scope of work or require a new Permit for the additional work.
- **Public Display.** All required Permits and approved plans must be available on the job site at all times during construction and during placement of traffic control devices. Failure to comply with this provision shall be grounds for a revocation of the Permit and the issuance of a stop work order.
- **No Reimbursement of Fees.** In general, once the Permit is approved and fees are collected, no Permit fee will be reimbursed, even if the Permit has expired before construction takes place.
- **Traffic Control Plans.** A Traffic Control Plan shall be submitted with the Permit Application for a proposed work for acceptance by the City Public Works Department, if applicable. Once the Traffic Control Plan is accepted, all plans, barricades, signs, traffic control devices shall be placed in accordance with MUTCD. The Applicant/Contractor shall be responsible for maintaining barricades and other safety devices at all times during construction operations.
- **Traffic Flow During Peak Hours.** No interference of traffic during peak hours will be accepted. Each Permit will acknowledge hours in which the Contractor can work on a particular road or right-of-way. Unless acknowledged by the City Public Works Department as an emergency, no traffic control can be on City roadways prior to 8:30 a.m. and after 3:30 p.m. unless otherwise stated on the Permit or by written confirmation of the City Public Works Department.

All work with traffic control in the field shall be performed by a certified Traffic Control Supervisor unless otherwise waived by the City in the application review process. The plan shall detail all devices; hours of work; days; dimensions of tapers and barricades; limits of work area; and requirements for closure of lanes, roads, and access points to commercial or residential properties. The City requires electronically generated plans for complex projects. For small projects, the City Public Works Department would prefer electronically generated plans, but if hand drawn, the plans must be legible and accurate.

- **Road Closure Requests.** If a contractor requests a road closure in their application for a Right-of-Way Permit, the following applies to any approved closures:
  - Road closures will require the written approval of the City Public Works Department. Proper posting and public notification will be required 7 days in advance of any closure. Forms of notification may include door hangers, variable message signs, and press releases.
  - Only one side of a street may be blocked at any given time. Traffic must be provided a minimum lane width of 10 feet in the construction area. Any plan for traffic control during construction that indicates a complete closure must show detour routes and must be approved by the City at least 1 week prior to Permit issuance.
  - For full closure, the Applicant will notify and get approval from the appropriate fire protection district, the County Sheriff's Office, and school district, concerning the exact location of street barricades and dates traffic will be impeded before approval from the City Public Works Department.
- **Application Requirements and Procedures .** The Permit holder must schedule a City inspection by contacting the City Public Works Department at least 24 hours, but not more than 120 hours, in advance of commencing work, or penalties of the stop work order may apply. If an inspection is scheduled with the City Public Works Department, and for any reason, work is not performed as scheduled, the permitholder must call and cancel the inspection as soon as possible. Failure to cancel the City inspection may result in a rescheduling fee levied against the licensed permitholder, revocation of the permitholder's license, or both.
  - The work of installing range boxes, surveying monuments, adjusting manhole rings and service boxes, or any similar work undertaken solely for the convenience and at the order of the City shall require a permit; however, the Permit may be issued on a "no fee" basis.
  - These Permits shall apply to Emergency Repair. An Emergency Cut shall be defined as a roadway excavation required to restore an essential service that has been disrupted or failed, or where delay of repair would cause further damage to the public right-of-way. Essential service shall be defined as electric, telephone, gas, water, and sanitary sewer, or other such service needed to protect the health, safety, and welfare of the public. Emergency Permits shall be processed within 3 business days of the emergency; typical fees, such as a street cut, will be assessed at that time.
  - All utilities shall obtain a Permit prior to beginning work in a future or existing City right-of-way. The practice of utilities using their own work order or job order to proceed with work in the right-of-way in lieu of obtaining a City Permit is prohibited.
  - Unless otherwise provided in the Special Provisions, the Right-of-Way Permit shall be in effect for 60 days from and after the date issued (however, a 60-day extension may be granted upon request with the possibility of additional fees), unless sooner revoked by the City Public Works Director or their designated representative for failure of the Applicant to abide by the terms and conditions of the permit, or by operation of the law, or at the time the utility for which the Permit is issued ceases operation. If the Applicant fails to complete installation of the facility covered by the Permit within the period specified in the permit, said Permit shall be deemed null and void, and all privileges and fees thereunder forfeited, unless a written extension of time is obtained from the City Public Works Director or their designated representative.

- Failure of the Applicant to comply with any of the terms and conditions of the Permit shall be sufficient cause for cancellation of the Permit and may result in removal of the utilities, approaches, or other facilities by the City at the Applicant's expense.
- The permit, the privileges granted herein, and the obligations of the Applicant created thereby shall be binding upon the successors and assigns of the Applicant.

- **Protection of Existing Improvements**
  - Existing Installations. The Contractor shall take proper precautions and be responsible for the protection of existing street and alley surfaces, driveway culverts, street intersection culverts or aprons, irrigation systems, mailboxes, driveway approaches, curb, gutter, and sidewalks, and all other public or private identifiable installations that may be encountered during the entire period of construction. Existing improvements to adjacent property, such as landscaping, fencing, utility services, signs, and driveway surfaces, that are not authorized for removal shall be protected from injury or damage resulting from the Contractor's operations.
  - Utilities. The Contractor shall always take proper precautions for the protection of existing utilities, the presence of which are known or can be determined by field locations of the utility companies, including traffic signals. The Contractor shall call in for locates for utility locates a minimum of 3 working days prior to the proposed start of work. The Applicant must coordinate and obtain approval of utilities prior to getting City approval.
  - Survey Markers. The Contractor shall take proper precautions for the protection of any property pins or corners and survey control monuments encountered during construction. Any damaged or disturbed survey markers or pins shall be replaced by a registered land surveyor at the Contractor's expense.
  - Responsibility for Repair. The repair or replacement of any damaged improvements as described previously shall be the responsibility of the Permit holder.
  - Minimizing Inconvenience. The Contractor shall abide by the requirements set forth by the Permit to minimize inconvenience to traffic and any inconvenience to adjacent property owners.
  - Adjacent Property Notification. The Contractor may be required to notify adjacent residents and businesses if utilities or infrastructure impedes access to roadways affected by construction.
- **Permanent Pavement Patches.** All permanent pavement patches and repairs shall be made with the original type of existing materials. For example, concrete patches in concrete surfaces, full-depth asphalt patches with full-depth asphalt, and concrete pavement with asphalt overlay patches will be expected in permanent "overlaid" concrete streets. In no case is there to be an asphalt patch in concrete streets or concrete patch in asphalt streets unless otherwise approved by the City. Any repair not meeting these requirements will be removed and replaced by the Contractor at their expense.
- **Backfill.**
  - Flow Fill. Use of Flow Fill or flash fill is to be used to backfill a trench in existing roadways at the discretion of the City Public Works Department.
  - Squeegee. Squeegee shall be used for a minimum of 12 inches above the pipe and bedding below the pipe.
  - Inspection. The City Public Works Department requires inspections of squeegee, Flow Fill, and preparation before patch. If any required inspection is not requested, the City Public Works Department may require removal and replacement of any work so that work can be inspected for quality and conformance to the standards and specifications.
- **Conformance to Standards**. All work is to be constructed in accordance with these Roadway Standards and Specifications.

- **Work to be Done in an Expedient Manner.** All work shall be done in an expedient manner. Repairs shall be made as rapidly as is consistent with high-quality workmanship and materials. Use of fast-setting concrete and similar techniques may be required and are encouraged whenever possible without sacrificing the quality of repair. Completion of the work, including replacement of pavement and cleanup, shall be accomplished immediately after the repair work or activity involving the cut is done. Extension of time for completion requires written approval of the City Public Works Department. If the repairs are not completed in the allotted time, the City has the right to repair the street and bill the full cost of work and administrative expenses to the Contractor. The City requires a reasonable, continuous, and diligent effort from the Contractor to complete work and daily cleanup. The Contractor shall have 48 hours to complete street patching.
- **Removal and Replacement of Unsatisfactory Work.** Removal and replacement of unsatisfactory work shall be completed within 15 days of written notification of the deficiency unless deemed an emergency requiring immediate action. If deemed an emergency for health and safety reasons, the Contractor must complete the work immediately.

  In the event the replacement work is not completed within the requirements, the City Public Works Department will take action against the Contractor's surety or bond to cover all related costs. If the Developer/Contractor does not pay for outstanding fees, the City Public Works Department may notify the guarantee holder that they may require the Guarantee to be paid out to the City.
- **Cold Patch or Metal Plate.** After excavation work is completed in existing roads for the day, but the project is not finished, the Contractor shall backfill base material and cover their excavation with cold patch or a metal plate with cold patched edges at the discretion of the City Public Works Department. To use a metal plate, the Applicant/Contractor is required to have prior approval on the permit. Generally, the City Public Works Department does not approve metal plates between October and April because of snow removal. Cold mix may be used for temporary use only and be in place no longer than 1 week.

  If the Contractor does not replace the cold mix within a week, or outstanding work remains, the City Public Works Department may restrict the Contractor's ability to receive any new Permits unless this work is appropriately completed or request payment through the Contractor's surety.
- **Non-Emergency Holiday, Weekend, or After-Hours Work.** If a Contractor would like to work on holidays, weekends, or after hours, they must request that work through the City Public Works Department. The Contractor shall make the request at least 1 week prior to the proposed work dates.

11.3 Stop Work Orders

Any person, corporation, quasi-governmental agency, special district, public utility, or private utility company that has performed work without first having obtained a Permit or has performed work in the right-of-way that is considered a safety hazard or has nonconforming items that have not been addressed will be issued a notice to stop work. All specified work shall be discontinued until such time that the appropriate repair or Permits are in place, or the City has been reimbursed for its expenses. The City, may, on its own initiative, make required repairs and bill the responsible contractor. The City Public Works Department or Inspector is authorized to issue stop work orders. The stop work order shall contain a written statement of the violations that caused the issuance. Immediately upon receipt of a stop work order, the Applicant shall consult with the City Public Works Department to resolve the violations. If weekend work caused by emergency occurs, the Contractor shall forward pictures to the City Public Works Department and notify the City Public Works Department.

11.3.1 Stop Work Fines

Any Applicant who does not immediately discontinue work upon issuance of a stop work order shall be subject to fines. The Applicant may be fined in accordance with the City's Municipal Code requirements.

11.3.2 Typical Reasons for Stop Work Order

Any Permit may be revoked or suspended by the City Public Works Department for the following typical reasons:

- Violations of any condition of the Public Improvements Agreement or of the approved construction drawings or specifications
- Violation of any provision of these Roadway Standards and Specifications
- Violation of any other Ordinance of the City, state law, or federal law pertaining to the work
- Existence of any condition or the occurrence of any act that may constitute or cause a condition endangering health, life safety, or serious damage to property
- No Right-of-Way Permit, or failure to comply with permit

11.3.3 Immediate Effects of Stop Work Order

A suspension or revocation by the City and stop work orders shall take effect immediately upon notice to the person performing the work in the field and shall remain in effect until such time as the City cancels the order in writing. A failure to abide by the terms of the suspension or revocation will be considered a violation of the Municipal Code.

Upon receipt of a stop work order, the Contractor shall be responsible for taking such precautions as may be necessary to prevent damage to the project, prevent inconvenience or hazardous conditions for the general public, provide for normal drainage, and erect any necessary barricades, signs, or other facilities that may be necessary or deemed necessary by the City Public Works Department.

No specified work may continue under the Permit and no subsequent Permits will be issued until the City Public Works Department receives full payment for Permits and City-incurred expenses, or poor workmanship or safety issues have been resolved.

11.3.4 Mitigation Expenses

In cases where the City Public Works Department deems it necessary to affect a remedial action or repair to mitigate any dangerous or unsafe circumstances caused by emergencies or untimely performance by the Applicant, the City Public Works Department may bill the Applicant for any of its costs. Untimely performance occurs when the Contractor has not performed the remedy within 24 hours of notification. Emergency repairs are expected to be implemented immediately.

11.3.5 Costs for Repairs

Mitigation repair costs shall include, but not be limited to, the following:

- Administrative charge
- All labor costs (at City rates)
- All material costs
- All equipment costs

11.4 Insurance Requirements for Permits

The following insurance requirements are intended to protect the public, as well as the Contractor who is providing any construction services in the public right-of-way.

Insurance: The Applicant shall obtain and carry a liability and property damage insurance policy or policies for the period of time required for complete installation of facilities authorized by the permit, including the

repair and restoration of the road facilities, and also during such future periods of time when operations are performed involving the repair, relocation, or removal of said facilities authorized by the permit. Coverage shall be provided against any claim, demand, suit, or action for property damage, personal injury, or death resulting from any activities of the Applicant, his officers, employees, agents or contractors in connection with the construction, installation, repair, or removal of the said facilities authorized by the permit. The said policy or policies shall include as named insureds: City of Castle Pines, its City Council, its officers, agents and employees, except as to claims against the Applicant, for personal injury to any members of the Council or its officers, agents and employees, or damage to any of its or their property. The said insurance shall provide coverage of property damage insurance, public liability insurance, and bodily injury insurance in an amount of not less than $400,000.00 each, or such other maximum amount as may be specified in the Colorado Governmental Immunity Act and protecting the City against any and all claims for damages to persons or property resulting from construction or installation of any required improvements, pursuant to this Agreement. The policy will provide that the City shall be notified at least 30 days in advance of any reduction in coverage, termination or cancellation of the policies. Such notice shall be sent to the Public Works Director by certified mail, return receipt requested. Contractor agrees that any subcontractors engaged by or for the Contractor to construct the required improvements shall maintain public liability coverage in limits not less than those mentioned in this paragraph.

11.4.1 Listing of Specific Requirements

The Applicant is responsible to provide insurance prior to the issuance of the Permit in accordance with the following requirements:

- The Applicant or the Applicant's Contractor shall present proof of carrying a liability and property damage insurance policy or policies known as Commercial General Liability for the period of time required for complete installation of facilities authorized by the permit, including the repair and restoration of the road facilities, and also, during such future periods of time when operations are performed involving the repair, relocation or removal of said facilities authorized by the permit. Coverage shall be provided against any claim, demand, suit, or action for the property damage, personal injury, or death resulting from any activities of the Applicant, his officers, employees, agents, or contractors in connection with the construction, installation, repair, or removal of the said facilities authorized by the permit.
- The policy shall include as named insured: The City, City Public Works Department, Risk Management, its officers, agents and employees, except as to claims against the Applicant, for personal injury to any members of the Council, its officers, agents and employees, or damage to any of its or their property. The said insurance shall provide coverage of property damage insurance, public liability insurance, and bodily injury insurance in the amount of not less than $1,000,000 each, or such other maximum amount as may be specified in the Colorado Governmental Immunity Act and protecting the City against any and all claims for damages to persons or property resulting from construction or installation of any required improvements pursuant to the permit.
- The policy will provide that the City shall be notified at least 30 days in advance of any reduction in coverage, termination, or cancellation of the policies. Such notice shall be sent to the City Public Works Department by certified mail, return receipt requested.
- The Applicant shall also obtain and keep in force during the duration of all work covered under the Permit a policy of Automobile Liability insurance with similar terms as mentioned previously. This policy shall insure the Applicant against any liability for personal injury, bodily injury, or death arising from the use of motor vehicles and shall cover operations on or off the site of all motor vehicles controlled by the Applicant.
- All Contractors shall have proof of worker's compensation on the Certificate of Insurance.

11.5 Security Requirements

The Security requirements are for the Contractor obtaining Permits. When the project is a development, the Owner/ Developer must provide separate security and insurance according to the SIA or other agreement for the public improvements.

11.5.1 Bonds

A non-cancelable Permit bond in the amount of the cost of the Public Improvements, but not less than $20,000 per permit, payable to the City of Castle Pines, shall be required in the name of the permittee prior to issuance of any permit. Said bond shall assure that the permittee will comply with all City standards and specifications and shall assure recovery by the City of any expense incurred, within a period of 365 days, following the expiration date of a permit, to the amount of said bond, because of a failure of the permittee to comply with the provisions of these Roadway Standards or to otherwise cause expense to the City as a result of the work performed. The described Permit bond is not required in the following cases (note that the Owner/ Developer may not use the Permit bond method in lieu of an SIA as collateral for their development):

1) The proposed work is included in the scope of an updated SIA, Development Agreement, or Contract.
2) The proposed work is to be performed for a Local Improvement District, Metropolitan District, for example, where an Intergovernmental Agreement has been executed.
3) The proposed work is to be performed for the City, and the contractor has provided the City with a Performance/ Payment Bond.

11.5.2 Revocation

Any Permit determined to be without an adequate security as required shall be subject to immediate revocation by the City.

11.5.3 Exception for Governmental Entities

Municipalities, quasi-governmental agencies, special districts, mutual companies, electric, gas, and communication utilities, may provide a Letter of Responsibility in lieu of posting the required bond.

11.5.4 Unacceptable Security

It shall not be acceptable to the City to receive cash deposits, certified checks or similar security in lieu of a Letter of Credit. Letters of Credit and Letters of Responsibility shall be filed in the office of the City Public Works Director.

11.6 Contractor License Requirements

The City Public Works Department requires the contractors who plan to work in the City's rights-of-way to have a contractor license with the City. Refer to the City's Municipal Code for these requirements. Contractor licenses shall take up to 10 days to process. Licenses can be obtained through the Building Department and can be found on the City's website.

11.6.1 Contractor License

Any person or person representing a corporation, governmental or quasi-governmental agency, special district, mutual company, utility or communication company, who must obtain a Permit for work on or under property owned by the City must be licensed by the City of Castle Pines to be knowledgeable of the specifications, testing, inspection, and procedures required by the City.

11.6.2 Use of License

Each person who is issued a license may designate six other persons who are authorized to obtain Permits on behalf of the license holder. The license holder is still responsible for the permitted work even though the Permit is obtained by their authorized representative.

The license holder or one of their six authorized representatives must be on the site of the permitted work at all times during construction. If a license holder or one of their authorized representatives is not present at the construction site, a stop work order for all work on the site may be issued until a responsible person arrives on site.

This license is good for a period of 2 years. At the end of 2 years, the license holder must take and pass another test and be issued a new license.

11.6.3 Revocation of License

If it is found that work performed under the Permit obtained by a licensed person is repeatedly substandard according to City requirements and specifications, the City may call a hearing to determine whether the license holder should

- Retain their license
- Have their license revoked
- Be given a probationary period

A person's license cannot be revoked unless the Public Works Director determines that allowing the licensed person to continue to obtain Permits and perform work on public property would be detrimental to the health, safety, and welfare of the general public.

Chapter 12 - Roadway Construction and Inspection Procedures

12.1 General

All earthwork and right-of-way construction shall be performed in accordance with the City of Castle Pines Roadway Design and Construction Standards. In these Roadway Standards, asphalt refers to hot bituminous pavement, existing bituminous pavement, or asphalt paving material. In case of discrepancy, the most stringent criteria shall take precedence as determined by the City.

Refer to Chapter 8 for Inspection and Testing Requirements related to bridges and structures.

12.1.1 Third-Party Testing

Results of tests and inspections performed by the testing firm in the employment of the Owners, Developers, or Contractors shall be submitted directly from the testing agency to the City Public Works Department within 10 working days after the testing or retesting date of field and laboratory tests. Failure to meet the above requirements may result in a Stop Work Order being issued along with penalties in accordance with these Roadway Standards. It is the responsibility of the third-party testing agency and the Owner/ Developer to review test data and assure conformance to testing frequencies outlined in these Standards. Failure to conform to Standards may result in non-acceptance of public infrastructure.

12.1.2 Rights-of-Way, Easements, and Storm Water Facilities

Any work performed inside a City right-of-way, associated easements, and all storm water facilities shall be tested by approved materials testing firms accredited by American Association of State Highway and Transportation Officials (AASHTO) on an annual basis. They must employ a full-time, registered Professional Engineer (PE) licensed in the State of Colorado who directly supervises the work of the firm. The costs of testing, retests, and associated reporting will be paid by the Owner/ Developer. All material testing reports must be from an AASHTO-accredited lab and must be certified by a PE.

12.2 Ancillary Structure Testing

12.2.1 Utility Trenches, Inlets, Manholes, and Junction Boxes Backfilling Materials, Placement , and Compaction

All utility trenches within the right-of-way, associated easements, and on all facilities shall be placed and compacted in accordance with these Roadway Standards.

12.2.2 Testing

Field moisture-density testing shall be performed during backfill operations from the bedding material up to the finished subgrade elevation. Minimum testing frequency shall be in accordance with the tables in this chapter. A sufficient number of tests shall be taken at various depths to confirm backfill compaction and moisture content specifications are met. The results of field density tests shall be submitted in packet form and reviewed by the City Public Works Department prior to paving surfaces and prior to preliminary acceptance of right-of-way features. Prior to receiving the test packet, it is the testing agency and Owner/ Developer's responsibility to assure conformance with testing frequency. Testing shall be done in accordance with this manual. Within the roadway area, trench compaction shall be in accordance with AASHTO T-99 or T-180.

12.2.3 Curb, Gutter, Sidewalk, CrossPans, and Minor Drainage Structures Subgrade Preparation

12.2.3.1 Subgrade

Subgrade shall be thoroughly compacted in accordance with the Specifications outlined in this chapter. The surface shall be smooth to the final grade on which the concrete or asphalt will be placed, with no humps or depressions.

12.2.3.2 Testing

Testing frequency for the subgrade shall be in accordance with the tables in this chapter. Once all testing is complete, the subgrade shall be proof rolled. All costs associated with testing, retests, and associated reporting will be paid by the Owner/ Developer. These test results shall be submitted to City Public Works Department for compliance review prior to paving and before initial acceptance.

12.2.4 Concrete

12.2.4.1 Materials

Concrete material, curing, and placement shall conform with the requirements of these Roadway Standards. Curing methods shall conform to ACI 301 standard specifications.

12.2.4.2 Placement

Concrete placement and finishing shall include methods per ACI, which will not reduce the strength or integrity of the final product.

12.2.4.3 Testing

Daily placement of concrete will require testing in accordance with this chapter, plus properties testing on the first three consecutive passing truck loads. If placement is by means of a pump truck, sampling will be from the point of placement (the end of the discharge hose). One set of five cylinders shall be made and used for compressive strength testing from one of the first three passing truck loads and every 50 subsequent cubic yards or portion thereof. In the event of there being only one or two truck load(s) placed, then all of the tests described previously will be required to pass, with one set of cylinders made for compressive strength testing.

12.2.4.4 Cold Weather Concrete Protection

From November 1st through April 15th when the mean daily temperature is less than 40°F or when concrete is placed with ambient temperatures below 40°F, cold weather protection shall be provided in accordance with these Roadway Standards.

All protection for the job must be onsite and reviewed by a City Inspector prior to beginning the concrete placement. After the concrete has been placed, the Contractor shall provide sufficient protection, such as cover, straw, thermal blankets, canvas, framework, or heating apparatus, to enclose and protect the structure and maintain the temperature of the concrete at not less than 50°F for a minimum of 5 days or until at least 60% of the design strength has been attained. It shall be the Permittee's responsibility to provide proof of temperature compliance through the use of maturity meters or with surface temperature recording devices, as certified (by a PE) by a testing laboratory. The maximum frequency for recording temperatures shall be 1-hour intervals. If surface temperature compliance data are not provided, the permittee may be required to provide the City with petrographic tests for every 50 cubic yards of concrete placed. Except as provided previously, cold weather placement of concrete shall be in accordance with

ACI-306. If in the opinion of the City Inspector, the protection provided is not in accordance with the specifications herein, placement of concrete shall cease until conditions or procedures are satisfactory to the City Inspector.

Note: Dates for Mean Daily Temperature as determined over the last 25 years by the Colorado Climate Center, Department of Atmospheric Science by: (min. temp. + max. temp)/2 (which is accurate to within plus or minus 1 degree).

12.3 Roadway Subgrade Preparation

12.3.1 Swell Mitigation Procedure

If swell mitigation is required in accordance with the approved Pavement Design Report, the swelling material shall be mitigated based on the approved measures. Field density tests and a proof roll shall be performed and accepted.

12.3.2 Compaction

Subgrade shall be prepared in accordance with these Roadway Standards. Certified compaction reports shall be required in accordance with these Roadway Standards prior to initial acceptance by the City.

To determine soil temperature, the subgrade will be checked at various depths below the surface as determined by the City Inspector. If there is the presence of ice crystals in the subgrade, or temperatures are recorded at or below 32°F, as determined by a City Inspector, it shall be considered frozen material.

12.3.3 Testing

Subgrade shall be tested in accordance with these Roadway Standards.

12.3.4 Final Proof Rolling

Subgrade, which is pumping, or deforming as determined by the City Inspector, must be reworked, replaced, or otherwise modified to form a smooth, stable, non-yielding base for subsequent paving courses. The proof roll shall be scheduled with the City Public Works Department at least 24 hours in advance, and the City Inspector shall be present at the time of the proof roll.

Table 12-1. Soil Characteristics

Soil Type	Compaction	Moisture
A-1, A-2, A-3	95% Min. of AASHTO T 180	-2 to +2
A-4, A-5, A-6, A-7	95% Min. of AASHTO T 99	0 to +4

12.3.5 Acceptance

The results of field moisture and density tests shall be submitted and reviewed by the City Public Works Department. Provided all tests are acceptable and the proof roll is approved, placement of the first paving course may proceed. Should testing and proof rolling indicate unsatisfactory work, the necessary reworking, compaction, replacement, retesting, and new proof roll will be required prior to continuation of the paving process. The testing and proof rolling are valid for 24 hours. Changes in weather, such as freezing or precipitation, will require retesting and proof rolling the subgrade. The City will review all testing prior to acceptance.

12.4 Lime- and Cement-Treated Subgrade

12.4.1 Materials

Construction of lime- and cement-treated subgrade shall not be allowed from October 1st through April 15th. Lime- and cement-treated subgrade shall be used only where a mix design has been previously submitted to and approved by the City Public Works Director or their representative.

12.4.2 Construction

Subgrade shall be in accordance with the proof roll standards. Acceptable compressive strength test results shall be in a range determined by the City. If cement treatment subgrade is used under concrete pavement, a bond breaker shall be used.

Note: If lime- or cement-treated subgrade is used for swell mitigation in accordance with Chapter 10 of these Roadway Standards, the lime- or cement-treated subgrade cannot be used to improve the R-value or the structural number.

12.4.3 Testing

Lime- and cement-treated subgrade shall be observed and tested on a full-time basis. Minimum sampling and testing shall be in accordance with the more stringent of current AASHTO and Colorado Department of Transportation (CDOT) specifications. Compaction curves (AASHTO T 220) will be required for each soil type, and field density shall be compared with the appropriate curve for percentage compaction determinations.

12.4.4 Acceptance

Test results shall be submitted and reviewed by the City Public Works Department. Provided all tests, including a proof roll, are acceptable, the subgrade will be approved, and the next paving course can be placed. The City will review all testing prior to acceptance.

12.5 Aggregate Base Course and Recycled Concrete Base Course

12.5.1 Materials

Aggregate base course materials must be from a currently approved source and conform to the requirements found in these Roadway Standards.

12.5.2 Placement and Compaction

Materials shall be placed on an approved subgrade that has been tested and proof-rolled within the past 24 hours and found to be stable and non-yielding. Should weather conditions change, such as freezing or precipitation, aggregate base materials shall not be placed until the subgrade is retested and proof rolled.

Aggregate base materials shall be moisture treated and compacted to 95% modified proctor and within 2% of optimum.

12.5.3 Testing

Testing shall be done in accordance with these Roadway Standards. Should the tests indicate the material does not meet specifications, the material shall be removed and replaced.

During placement and compaction, compaction curves will be required for each material used. Field moisture-density tests shall be taken on each lift of material at random locations at approximate intervals of 200 linear feet in each travel lane.

12.5.4 Proof Rolling

After the base course has been compacted, tested, and found to meet specifications, base course, which is pumping or deforming, must be reworked, replaced, or otherwise modified to form a smooth, stable, non-yielding base for subsequent paving courses. The proof roll shall be scheduled 24 hours in advance with the City, and a City representative shall be present at the time of the proof roll.

12.5.5 Acceptance

The results of field moisture/ density tests and proof rolling shall be submitted and reviewed by the City Public Works Department. Provided all tests are acceptable, and the proof roll is approved, placement of the first paving course may proceed. Should testing and proof rolling indicate unsatisfactory work, the necessary reworking, compaction, replacement, retesting and new proof roll will be required prior to continuation of the paving process. Approval testing and proof rolling are valid for 24 hours. Changes in weather, such as freezing or precipitation, will require reapproval, re-testing, and proof rolling of the base course.

12.6 Asphalt

12.6.1 Materials

All asphalt, aggregate, fillers, and additives shall be combined to form a mix design in accordance with Chapter 10 of these Roadway Standards. The mix design must be submitted to and approved by the City Public Works Department every 2 years. If any element of a mix design changes, a new mix design submittal is required.

12.6.2 Placement and Compaction

Materials shall be placed on an approved subgrade, base course, or previous paving course in accordance with these Roadway Standards.

If more than one theoretical maximum specific gravity test is taken in a day, the average of the theoretical maximum specific gravity results will be used to determine the percentage of compaction.

Self-propelled pavers shall be provided that are capable of spreading and finishing the asphalt paving material in full lane widths applicable to the typical section and thicknesses as discussed at the pre-paving conference or shown in the Contract documents and shall be equipped with the following:

- Anti-segregation devices
- A vibratory screed assembly capable of being heated

Pavers used for shoulders, patching, and similar construction not requiring fine-grade control shall be capable of spreading and finishing courses of asphalt to the required widths and depths as shown in the Contract without segregation.

The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.

The paver shall be capable of operation at forward speeds consistent with uniform and continuous placement of the mixture. Stop-and-go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, segregating, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of detecting grade provided by a source of reference line and maintaining the screed at the specified longitudinal grade and transverse slope. The sensors may be contact or non-contact-type devices. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

- Grade control device at least 30 feet in length
- Joint matching device
- Adequate length of control line and stakes if no other type of geometric control is present
- A straight edge at least 10 feet in length that will be available to verify the crown on the screed, at the City's request

The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1%. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.

If the Contractor fails to obtain and maintain the specified thickness or surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made. Placement of asphalt paving material on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering. Material placed that does not meet thickness requirements shall be removed and replaced. Material placed that does not meet smoothness requirements shall be removed and replaced or diamond ground so long as thickness requirements are still met after grinding.

Redistribution of the mixture using hand tools is only permitted when necessary around utilities and in areas inaccessible to equipment. Casting or raking will not be allowed.

Asphalt shall be placed only on properly prepared, unfrozen surfaces that are free of water, snow, and ice. The asphalt shall be placed only when both the air and surface temperatures equal or exceed the temperatures specified in Table 12-2 and the City Inspector determines that the weather conditions Permit the pavement to be properly placed and compacted.

Table 12-2. Placement Temperature Limitations in °F

Compacted Layer Thickness (inches)	Minimum Surface and Air Temperature °F	
	Top Layer	Layers Below Top Layer
< 1.5	60	50
1.5 to 3	50	40
> 3[a]	45	35

Note: Air temperature is taken in the shade. Surface is defined as the approved subgrade, base course, or previous paving course on which the new pavement is to be placed.

[a] Requires Preapproval from the City Public Works Department.

The minimum temperature of the mixture when discharged from the mixer and when delivered for use shall be as shown in Table 12-3. Mix temperatures will be checked on each load behind the paver screed. Where the temperature does not meet specifications, the material shall be rejected.

Table 12-3. Mix Temperatures

Asphalt Grade	Minimum Mix Discharge Temperature (°F)[a]	Minimum Delivered Mix Temperature (°F)[b]
PG 58-28	275	235
PG 64-22	290	235

[a] The maximum mix discharge temperature shall not exceed the minimum discharge temperature by more than 30°F.

[b] Delivered mix temperature shall be measured behind the paver screed.

12.6.3 Testing

Asphalt pavement testing shall be performed in accordance with these Roadway Standards. The tests shall be performed under the general supervision of a PE licensed in the State of Colorado. Laboratories shall be accredited by AASHTO for tests being performed to an AASHTO standard or an equivalent test method. Technicians taking samples and conducting compaction tests must have LabCAT Level A certification. Technicians conducting tests of asphalt content and gradation must have LabCAT Level B certification. Technicians performing volumetric testing must have LabCAT Level C certification.

If any materials furnished or work performed fails to fulfill the specification requirements, such deficiencies shall be reported to the City Public Works Department or City Inspector on the day of paving. Written field reports of all tests taken, and observation results shall be given to the Contractor, City Inspector, City, and Developer within 10 business days after samples were obtained or density testing performed. Failures should be reported to the City within this time duration.

Nuclear density test results shall be corrected using Colorado Procedure 82 Field Correction of the In-Place Measurement of Density of Bituminous Pavement by the Nuclear Method. A new calibration should be developed for each change in mix design, pavement lift, or underlying surface. Results of nuclear density test results shall be reported to the Inspector/ project superintendent at the time the testing occurs. **Nuclear density test results are for information only and are not to be considered for acceptance.**

If the Contractor chooses to cover a lower asphalt lift before that material has been accepted, and it is determined that the lower lift is not within the tolerance variance, then both the lower lift(s) and upper lift will be removed and replaced.

Mix temperatures will be checked on each load behind the paver screed. Where the temperature does not meet specifications, the material shall be rejected and removed immediately.

If requested by the City, upon completion of the paving, the final pavement thickness and density may be determined by taking cores. Core density shall be determined by coring after each lift of asphalt is placed. The cores shall be taken at random locations at intervals of approximately 500 feet in each travel lane as determined and marked by the City Inspector. The City Inspector must be present during actual core drilling, or cores will not be accepted. The core holes shall be repaired with asphalt paving material or other approved products.

Profilograph tests may be required prior to initial and Final Acceptance on collector and arterial roadways. Profilographs shall be performed by a certified independent testing consultant with data supplied to the City within 5 working days. Profilographs shall be performed according to CDOT specifications.

Table 12-4. Job Mix Formula Production Tolerance Zones

Element	Reference Conditions		
	Within Tolerance (GREEN)	Tolerance Variance (YELLOW)	Out of Tolerance (RED)
Asphalt Content	±0.3%	+0.5/ -0.4%	+0.51/ -0.41%
Air Voids	±1.2%	±2.4%	±2.5%
VMA	±1.2%	±2.4%	±2.5%
Percent Relative Compaction– Mat	94 ±2%	N/A	N/A
Percent Relative Compaction– Joint	92 ±4%	N/A	N/A
Passing the 3/8-inch and Larger Sieves	±6%	±9%	±10%
Passing the No. 4 and No. 8 Sieves	±5%	±8%	±9%
Passing the No. 30 Sieve	±4%	±6%	±7%
Passing theNo. 200 Sieve	±2%	±3%	±4%

Note:

VMA = Voids in Mineral Aggregate

Condition Green will exist when all elements are within Tolerance. Condition Yellow will exist when any element falls outside of the Within Tolerance Zone (Green) and has not exceeded the Tolerance Variance Zone (Yellow). If any of the elements fall in the Tolerance Variance Zone (Yellow), the Contractor shall notify the Supplier and corrections shall be made. While elements are in the Tolerance Variance Zone (Yellow), paving operations may continue while corrections are made, provided in-place densities meet the specifications. While elements are in the Tolerance Variance Zone (Yellow), samples will be taken daily until the mix is back in the Within Tolerance Zone (Green). In the event the mix has not been brought back to Within Tolerance (Green) by the end of the third day's paving operations, or at any time the tests move into the Out of Tolerance Zone (Red), production or paving operations will be suspended until corrections are made and the mix is verified against CDOT Standard Specifications.

12.6.4 Acceptance

The results of field density and laboratory tests shall be submitted to, and reviewed by, the City. Provided all tests are acceptable, the asphalt concrete materials, placement, and compaction will be approved. Acceptable results shall be in compliance with specified tolerances.

Should testing indicate unsatisfactory work, removal and replacement or overlay work will be required as determined by the City's Public Works Director.

Requirements:

- All (100%) mat cores must pass 94% (plus or minus 2.0%) of the theoretical maximum specific gravity (Rice Value).
- All (100%) longitudinal joint cores must pass 92% (plus or minus 4.0%) of the theoretical maximum specific gravity (Rice Value).
- All Lottman (Tensile Strength Ratio, % Retained, CP-L 5109) shall be equal to or greater than 70%.

12.6.5 Hot Mix Asphalt Test Result Dispute Resolution

If the Contractor wishes to dispute the results of a failing test, then a split sample (in accordance with CDOT Field Materials Manual) shall be provided to a certified third-party laboratory within 10 working days after the testing date of the original laboratory test. The results of the retest shall replace those of the original test. The Contractor shall be responsible for paying for the retesting.

12.7 Portland Cement Concrete

12.7.1 Materials

All aggregate, Portland cement, fly ash, water, admixtures, curing materials and reinforcing steel shall meet the requirements of these Roadway Standards. All materials shall be combined in accordance with the mix design, submitted to, and approved every 2 years by the City.

12.7.2 Construction Requirements

Materials shall be proportioned, handled, measured, batched, placed, and cured in accordance with these Roadway Standards.

12.7.3 Cold Weather Concrete Protection

From November 1st through April 15th when the mean daily temperature is less than 40°F or when concrete is placed with ambient temperatures below 40°F, cold weather protection shall be provided in accordance with these Roadway Standards.

All protection for the job must be onsite and reviewed by the City Inspector prior to beginning the concrete placement. After the concrete has been placed, the Contractor shall provide sufficient protection, such as cover, straw (as determined by R-factor per ACI specifications), thermal blankets, canvas, framework, or heating apparatus, to enclose and protect the structure and maintain the temperature of the concrete at not less than 50°F for a minimum of 5 days or until at least 60% of the design strength has been attained. It shall be the Permittee's responsibility to provide proof of temperature compliance through the use of maturity meters or with surface temperature recording devices, as certified (by a PE) by a testing laboratory. The maximum frequency for recording temperatures shall be 1-hour intervals. If surface temperature compliance data are not provided, the permittee shall be required to provide the City with petrographic tests for every 50 cubic yards of concrete placed. Except as provided previously, cold weather placement of concrete shall be in accordance with ACI-306. If in the opinion of the City Inspector, the protection provided is not in accordance with the specifications noted previously, placement of concrete shall cease until conditions or procedures are satisfactory to the City Inspector.

Note: Dates for Mean Daily Temperature as determined over the last 25 years by the Colorado Climate Center, Department of Atmospheric Science by: (min. temp. + max. temp)/2 (which is accurate to within plus or minus 1 degree).

12.7.4 Testing

During placement of Portland cement concrete pavement, observation and testing shall be on a full-time basis. For each day of production, change in source or supplier, or every 400 cubic yards placed (or portion thereof), aggregate samples shall be obtained at the batch plant for gradation of both the coarse and fine aggregates.

Slump, air content, unit weight and mix temperature shall be tested every 50 cubic yards of pavement placed. Daily placement of concrete will require testing of slump, air content, unit weight, and mix

temperature on the first three consecutive passing loads. Sampling will be from the point of placement. If any one test fails to meet the requirements, testing shall continue until loads meet requirements. Thereafter, slump, air content, unit weight, and mix temperature shall be tested at least every 50 subsequent cubic yards or portion thereof.

A minimum of five compressive-strength cylinders shall be fabricated for each 50 cubic yards placed. Cylinders shall be tested as follows: one at 7 days, three at 28 days and one for backup, as required by the City. Testing intervals may be increased at the discretion of the City Inspector.

Portland cement and fly ash will be accepted on the basis of current certificates of compliance and pre-testing by CDOT. Reinforcing steel, dowels, and tie bars will be accepted by certificate of compliance and mill reports. Water, if not potable, shall be sampled and tested before use. Only CDOT-approved brands of air entraining agents, chemical admixtures, and curing materials may be used and must be documented.

Surface smoothness shall be tested and corrected as necessary. Acceptance profiles shall be performed per CDOT specifications. Hand-placed concrete tested with a 10-foot straightedge shall have a deviation of no more than 3/16-inch in 10 feet. This requirement is for all concrete mainline pavement. Defective concrete pavement shall be corrected as necessary.

Concrete thickness shall be verified by coring after construction at random locations at intervals of approximately 500 feet in each travel lane as determined and marked by the City Inspector. The City Inspector must be present during actual core drilling, or cores will not be accepted. Core holes shall be repaired with an approved high-strength epoxy grout or other approved material.

A Final Acceptance profile test shall be conducted after all corrections and repairs are made. Acceptance profiles shall be performed by a certified profiler with data supplied to the City within 5 working days following the test.

Curing methods shall conform to ACI 301 standard specifications.

12.7.5 Acceptance

All test results shall be submitted to and reviewed by City Public Works Department or their representative. The pavement will be accepted once all tests are approved and applicable repairs or corrections have been made. Should testing indicate unsatisfactory work, removal and replacement or grinding will be required.

12.8 Other Materials

12.8.1 Asphalt Prime and Tack Coats General

Prime coat is the application of a diluted, emulsified asphalt or cutback asphalt (as allowed by federal or state law) to previously prepared aggregate base course or granular soil subgrade prior to placing asphalt concrete. The prime penetrates into the base or subgrade, plugs the voids, binds the fine aggregate at the surface, waterproofs the surface until the asphalt concrete surfacing is placed, and helps prevent the surfacing from shoving following construction.

Tack coat is a very light application of asphalt (usually diluted emulsified asphalt) to create a bond between the asphalt concrete being placed and underlying pavement or adjacent features, such as gutter faces, valve boxes, manholes, and rings. A tack coat prevents a slip plane in overlays and seals joints between the paving and other appurtenances. It must be applied uniformly and lightly. Too heavy a tack coat is less desirable than none at all. A tack coat is used when the surface to be overlaid is old, glazed, dried out or subjected to dust or traffic film. Tack coats are sometimes omitted between asphalt courses of new pavements if the succeeding course is placed within 24 hours. If the surface of the underlying course is contaminated by sand, dust, or foreign material deposited by traffic or wind, merely brooming is not completely effective. A very light tack coat should be applied after brooming.

12.8.2 Materials

Emulsified asphalt shall meet the requirements of these Roadway Standards.

12.8.3 Application

Before prime coat application, the surface should be allowed to dry to approximately 80% of optimum moisture. Application shall be made with a self-propelled pressure distributor capable of uniform distribution at the rate specified. The distributor should be calibrated and equipped hydraulically, or with tie downs, so the spray bar will maintain a uniform height above the surface being primed. The asphalt material shall be applied in the range of 0.20 to 0.40 gallon/square yard. If the surface being primed is very tight textured and appears fairly non-absorbent, use the lower end of the range. If the surface is more open textured and appears more absorbent, use the higher end of the range. Apply as much material as the surface will absorb in a reasonable period of time. If an excess is applied, use a blotter material (sand or aggregate base material) to absorb the excess.

Tack coat is applied with a self-propelled pressure distributor that is in good condition, clean, and has been calibrated with nozzles set properly for fan overlap and not plugged. The spray bar should be capable of being set hydraulically, or tied down, so the bar is maintained at a uniform height from the application surface. A 1:1 dilution should be applied at 0.10 gallon/square yard. Greater dilutions should be applied at heavier rates. A wand or hand-spray nozzle attached to the spray bar can be used for applying tack to gutter faces, valve boxes, manholes, and rings. In lieu of the wand, a hand sprayer, or as a last resort, a mop and bucket, may be used. Care must be taken with the wand, sprayer, and especially a mop so that a very light coating is applied, and the emulsion is not sprayed on the surfaces where paving will not be used. Sloppy workmanship shall not be tolerated. The tack coat must be evenly distributed over the entire surface.

12.8.4 Curing

When applied, emulsified asphalt will be brown in color. When the emulsion breaks (dehydrates), it will separate into its two components, asphalt cement and water, and turn black in color. Following the break, the water must evaporate before placing asphalt concrete. The prime or tack coat will be sticky or tacky when cured. The length of time required for curing will depend on the surface temperature, air temperature, humidity, and wind conditions. On a hot, dry, windy day, the prime or tack coat will cure in an hour or so. Cooler, more humid, cloudy, and still conditions will extend this time period.

12.8.5 Acceptance

Prime or tack coat will be approved by the City upon acceptance of mill certifications, visual approval, and verification of application rate. Dust or contamination of prime or tack coats will require brooming and reapplication.

12.8.6 Joint/Crack Sealant

12.8.6.1 Hot Poured Joint and Crack Sealant

This item shall consist of furnishing all materials, equipment, labor, cleaning and clean up, traffic control, and incidental items necessary for sealing or filling cracks of asphalt pavements. The purpose of crack sealing and crack filling is to prevent the intrusion of water and incompressibles. Crack sealing shall be applicable for cracks determined by the City Public Works Department. Crack filler is recommended for cracks that are 1 inch or wider or exhibit edge deterioration. Crack sealer is used for working cracks, and for cracks that have more than a quarter-inch seasonal movement. Both hot and cold materials are currently available for crack sealing; however, this specification is meant to only apply to hot applied materials. Crack filler should be used for nonworking cracks. Nonworking cracks are cracks that have annual movement of less than one-quarter inch. Nonworking crack types may include wide transverse cracks. If a crack exhibits edge deterioration, it should be filled not sealed.

12.8.6.2 Concrete Joint Fillers

The joint sealant for all sawed longitudinal and transverse joints shall be a silicone joint sealant meeting ASTM D5893. ASTM C1193 provides guidance for use of joint sealants. Blocking medium shall be an expanded, closed-cell polyethylene foam-backer rod or nonplastic rope that is compatible with the joint sealant material and meets ASTM C1330, Type C, or ASTM D5249. Polyethylene expansion joint materials shall be flexible, low-density, expanded-extruded polyethylene plank formed by the expansion of polyethylene base resin, extruded as a multicellular, closed-cell, homogeneous foamed polyethylene. Laminations shall not be permitted. The joint material shall conform to ASTM D1751, ASTM D1752, or ASTM D8139.

12.9 Road Cuts

12.9.1 Small Trench Cut in an Existing Roadway

This section is generally reserved for small road cuts from utility locates, water line repairs, sewer line repairs, electrical line repairs, gas main, phone lines, fiber-optic lines, cable lines, or service line repairs with damage to pavement areas. Unless preapproved, small trenches must be closed and temporarily resurfaced by the end of the workday. Trenches in existing roadways shall be backfilled with a preapproved material and the surface restored to use by the end of the workday through the use of accepted materials.

Final surface restoration shall be completed within 24 hours of temporary surface placement, excluding concrete curing. For roadways where concrete is involved, high, early-strength concrete may be required. For damaged or disturbed concrete pavements, sidewalks, curbs, gutters, cross pans, fillets, and curb ramps, the entire panel or section must be removed and replaced.

If more than 255 square feet of existing roadway is disturbed (from single street cuts on Arterial or Collector streets to multiple street cuts on Local streets) within a single block, the construction area shall be milled and overlaid per the direction of the City Public Works Department. The mill and overlay shall encompass all of the disturbed asphalt areas in a rectangular shape. Refer to Castle Pines Municipal Code for additional street cut regulations. Standard trench patching shall be required immediately following the initial road cut(s). T patching and infrared repair is required on all asphalt repair or replacement.

12.9.2 Trenches Crossing a Roadway

Unless otherwise approved in writing by the City Public Works Department, all trenches crossing a roadway shall be perpendicular to the direction of travel. The sides of the trench shall be saw cut smooth a

minimum of 1 foot from the edge of the trench. The road surface shall be replaced in accordance with Standard Detail SD. 47, matching the existing pavement grade and maintaining proper drainage. In concrete roads, the pavement thickness shall be the same as existing, but the panel must be doweled in the existing pavement as shown in the Standard Details. Unless otherwise approved, all trenches crossing in asphalt road surface that are less than 5 years old shall be milled and overlaid with approved materials a minimum of 10 feet on both sides of the trench for Local roadways and a minimum of 50 feet on both sides of the trench for Collector and Arterial roadways.

12.9.3 Longitudinal Trenches within a Roadway

Longitudinal trenches within a roadway shall be straight and will generally be a consistent distance from either the centerline of the road or flow line, as specified. Meandering will not be allowed. All pavements shall be saw cut a minimum of 1 foot beyond the edge of the trench before patching. If the distance between the edge of the trench and the lip of gutter, cross pan, or edge of pavement is less than 6 feet, all pavement to the lip of gutter, cross pan, or edge of pavement shall be removed and replaced. At a minimum, removed asphalt pavements shall be in accordance with Standard Detail SD. 47.

Pavements within arterials and collectors shall have the final repairs completed within 24 hours of the completion of the work requiring a road cut. All permanent repairs and temporary patches shall restore the pavements to existing or better conditions than existed before construction. Temporary patches in roadways shall be completed by the end of each working day.

Final repairs of pavement within local streets shall be completed within 5 days of the completion of the work requiring a road cut. At no time will more than 800 feet of trench be allowed to be unrestored or temporarily patched. All patches shall restore the pavement to existing or better condition than existed prior to construction.

In roadways whose surface is more than 5 years old, a minimum 12-foot-wide mill and overlay to a depth of 2 inches is required for the length of the trench before the end of construction. The edge of trench should not be in the wheel path. Where the trench straddles two or more traffic lanes, both lanes shall be milled and overlaid to a depth of 2 inches for the length of the trench before the end of construction.

Local streets shall be patched in accordance with Standard Detail SD. 47. Where multiple trench cuts occur in the street, the construction area shall be milled and overlaid by the end of the project. The mill and overlay shall encompass all of the disturbed asphalt areas in a rectangular shape.

In roadways whose surface is less than 5 years old, the half of the roadway disturbed by construction shall be milled and overlaid to a depth of 2 inches for the length of the trench before the end of construction. This restoration section shall extend from the centerline of the roadway to the lip of the gutter or pan. Should the road surface on both sides of the centerline be damaged as a result of construction activities, the entire surface of the roadway shall be milled and overlaid.

At no time will more than 800 feet of road be disturbed and unavailable for the public use, unless approved in writing by the City Public Works Department.

All final road restoration shall be completed within 24 hours of the temporary patch unless otherwise approved by City Public Works Department or their representative. Failure by the Contractor to perform the required restoration may result in the work being done though the City, with all costs charged to the project Owner or Contractor. Failure to remit payment for all incurred costs within 30 days of written notice may incur additional finance charges, project acceptance delays, and collection fees.

12.9.4 Potholes for Locates or Subsurface Investigations in Asphalt Pavements

Potholes for utility locates shall be done by means of a 3- to 6-inch-diameter core drill through the existing roadway surface. Potholes in asphalt roadways with a surface disturbance less than 1 square foot shall be repaired using preapproved pavement materials with an infrared surface treatment.

12.9.5 Potholes for Locates or Subsurface Investigations in Concrete Pavements

Potholes for utility locates shall be done by means of a 3- to 6-inch-diameter core drill through the concrete surface. Potholes in concrete pavement shall be plugged using a preapproved, fast-setting pavement concrete. More than two cores in a concrete pavement, including any previous core, or single disturbed area greater than 1 square foot, shall require the entire panel to be removed and replaced.

For potholes in sidewalks, curbs, gutters, fillets, curb ramps, cross pans, and other small concrete placements, the entire concrete section shall be removed and replaced.

12.9.6 Amount of Unpaved Roadway Trench

At no time shall more than 800-feet of a trench or trenches be without final restoration and useable by the public. Situations other than a temporary surface patch, approved by the City Inspector because of weather or the need to gain access for final tie-in work, must be approved in writing by the City Public Works Department or its assignee prior to the road surface being cut. Before paving, the Contractor or the project Owner shall verify passing compaction density tests and pass a proof roll. The City Public Works Department verifies test results prior to acceptance or Permit close out.

12.9.7 Trenchless Technology – Bores and Missiles

Trenchless construction for dry utilities using missiles, rams, unguided bores, or any other type of limited control devices is not allowed in the right-of-way. Only machines with fully controlled boring heads are permitted.

The individual Contractor shall warranty the work for a period of 5 years for heave or settlement. In areas where the exact depth and location of sewer mains or services is not known, the Contractor shall pothole to determine the depth or shall have a TV video survey done of the sewer line or service, prior to construction. The Contractor shall again video survey the sewer line or service after construction is complete to demonstrate the lines have not been damaged. A videotape of the before and after conditions shall be submitted to the City Public Works Department within 30 days of completing boring operations.

12.10 Quick Reference

Table 12-5. Castle Pines minimum Testing Requirements

Item	Type of Test	Minimum Frequency
Dry Utilities; Gas, Electric, Phone and Cable TV Trenches (Backfill)	Moisture/ Density	1 per 200 lane feet Every 1 foot in elevation and 1 foot from all structures every 1 foot in elevation
Wet Utilities: Sanitary & Storm Sewer, Water Line Trenches, Services (Backfill) (Full-Time Tester)	Moisture/ Density	1 per 200 lane feet every 1 foot in elevation, and 1 foot from all structures, manholes, valves, and other obstacles every 1 foot in elevation

Table 12-5. Castle Pines minimum Testing Requirements

Item	Type of Test	Minimum Frequency
Inlets (Concrete)	Air, Slump, Unit Weight, Temperature	First three consecutive passing loads, every 50 cubic yards thereafter
	Cylinders	1 set per 50 cubic yards
	Steel	Visual documentation
Inlets (Backfill)	Density	1 foot in elevation around structure every 1 foot in elevation
Sidewalk, Curband Gutter (Subgrade)	Moisture/Density	1 per 200 lane feet every 1 foot in elevation
	Proof-roll	All subgrade
Sidewalk, Curband Gutter (Concrete)	Air, Slump, Unit Weight, Temperature	First three consecutive passing loads, every 50 cubic yards thereafter
	Cylinders	1 set per 50 cubic yards
Roadway (Subgrade)	Moisture/Density	1 per 200 lane feet every 1 foot in elevation
	Proof-roll	All subgrade
Roadway (Base Course)	Gradation and Atterberg Limits	1 per 2,000 tons
	Moisture/Density	1 per 200 lane feet
	Proof-roll	All base course
Roadway (Concrete) (Full-time Tester)	Air, Slump, Unit Weight, Temperature	First three consecutive passing loads, every 50 cubic yards thereafter
	Cylinders	1 set per 50 cubic yards
Roadway (Asphalt) (Full-time Tester)	Density by Nuclear Gauge	1 per 200 lane feet
	Asphalt Content, Gradation, Air Voids, VMA	1 per 1,000 tons or minimum 1 per each days production sampled at paver
	Lottman Striping TSR and Dry Density	One per project per mix used
Roadway (Asphalt and Concrete)	Cores (Thickness and Density Verification) per Request	1 per 500 lane feet
Roadway	Smoothness Profile	Arterials and Collectors

Chapter 13 - Public Infrastructure Acceptance Procedures and Warranty Requirements

13.1 Applicability

Before the City assumes ownership and maintenance responsibility for newly constructed public improvements, the public improvements shall be formally accepted by the City Public Works Department. The Developer (Development Projects) or the Contractor (Capital Improvement Projects) is responsible for the proper installation of all improvements. Please refer to the City's website to obtain the Acknowledgement of Public Improvement Procedures document and checklist.

Failure by the City's representatives to detect improper installations or defects during the construction of improvements or during subsequent inspections does not relieve the Developer or Contractor of the responsibility to correct such defects at a later date. There shall be no partial acceptances of public improvements within new developments. All phasing of the public infrastructure shall be approved and determined prior to the start of construction. The security shall match to each approved Phase. The Developer or Contractor is fully responsible for maintenance and operation of any constructed public facilities until such time as the City formally accepts the public improvements or as outlined in the Subdivision Improvements Agreement (SIA) or other pertinent document or contract. The Developer or Contractor is responsible for a 2-year warranty of the public improvements constructed. The 2-year warranty starts with the signed and written Initial Acceptance.

The requirements contained herein shall apply to all new development and redevelopment and all other work affecting rights-of-way that are planned for public use within the jurisdiction of the City of Castle Pines.

These requirements may be enforced by stop work orders, and then if there are continued violations, work stoppage injunctions issued by the District Court pursuant to law or suit may be filed by the City Attorney for damages resulting to rights-of-way that are planned for public use as a result of noncompliance with these requirements.

13.2 General Policies

For City roads, sidewalk, and drainage public improvements required for a subdivision, the initial capital cost shall be paid by the Developer as well as operation and maintenance (O&M) through the warranty period until Final Acceptance. After Final Acceptance of the roads, the City will then provide a normal level of maintenance as available funds, staffing, and equipment permit. A normal level of maintenance consists of street sweeping, snow plowing, repair and cleaning of City-owned drainage structures, and general maintenance of the roadway in a condition deemed safe by the City Public Works Department.

The City will maintain only those roads, drainage improvements, and other public improvements specifically accepted for maintenance by the City Public Works Director and included in the SIA or relevant development or construction agreement.

Roadways shall not be opened to the general public until necessary permanent traffic control devices have been installed. Before a new roadway is accepted by the City, it shall be properly signed and striped according to the approved plans.

Prior to Initial Acceptance, all public improvements shall be completed as specified in the Improvement Agreement and on City-approved construction plans.

13.3 General Acceptance Process for Public Improvements

The Developer or Contractor shall be required to meet the following processes prior to the City's initial and Final Acceptance of the public improvements and any operations or maintenance.

13.3.1 Completion of Work

Completion of all Public Improvements required in the Public Improvements Construction Plans, specifications, and agreements in accordance with these Roadway Standards. The City shall approve plans prior to any construction work.

13.3.2 Written Request – Initial Acceptance

The Developer or Contractor shall notify the City Public Works Department, in writing, of the completion of the public infrastructure for the specific project. An Acceptance form, including all relevant checklist items is available by request to the City Public Works Department. The Developer or Contractor shall only make this request after all work is completed on the project. If the work is not completed when request is submitted, the City shall reject the request for acceptance until all work is completed.

13.3.3 Inspection and Creation of Deficiencies List

Storm drainage utilities shall be inspected throughout installation and upon completion of installation, and before paving operations, a deficiencies list shall be generated stating all discrepancies that relate to storm drainage utilities. After the completion of the utilities punch list, the remaining improvements can be completed. Water and sanitary sewer improvements shall be processed and approved by the applicable Water and Sanitation District prior to City approval for roadway work. Testing data in wet utility trenches is still required for acceptance if the utilities are located in the right-of-way.

Once the City has received a written request for acceptance, the certification of storm drainage detention and Record Drawings, the City Public Works Department will instruct a City Inspector to schedule an inspection of all required improvements. The Developer and/or Contractor will be invited to accompany the City's representative on all such inspections. The construction of public improvements will be inspected for conformance with the approved Public Improvement Construction Plans, the Official Development Plan (if applicable), the Public Improvements Agreement (if applicable), project specifications, these Roadway Standards, and Municipal Code. If the inspection cannot be performed as a result of excessive dirt or snow on streets, poor weather conditions, inaccessibility, or other reasons, the Developer or Contractor will be notified of the need to postpone these activities until the cause of the delay can be rectified. Deficiencies noted during the inspection will be compiled in a corrections list to be emailed or mailed to the Developer or Contractor for repair, replacement, or correction.

13.3.4 Correction of Deficiencies

Deficiencies list items shall be corrected within 60 days of the date this list is sent to the Developer or Contractor. If all noted deficiencies are not corrected within this time, the public improvements may be reinspected, and any new defects may be added to the deficiencies list. Public improvements will not be accepted until all noted deficiencies are corrected within the proper time frame. The City Inspector shall be notified before any corrective work commences and immediately upon the completion of the repairs. The City may require the Developer to pay for the additional consulting costs for walkthroughs and punch lists.

13.3.5 Record Drawings

A complete set of "as-constructed" drawings of the public improvements shall accompany the request for acceptance. The as-builts shall be surveyed and stamped by the surveyor and Engineer of Record and submitted prior to Initial Acceptance. Upon acceptance by the City, the Developer or Designer will be required to submit a certified set of electronic "as-constructed" drawings. The submittal shall include a PDF set and AutoCAD .dwg files. These drawings shall be prepared on 24-inch-by-36-inch sheets, and lettering should be no smaller than one-eighth inch. The City may request printed drawings at 11 inches by 17 inches. The text must be readable. At a minimum, Record Drawings shall indicate the horizontal or vertical layout of all underground water, sanitary sewer, and storm drainage facilities (including distances between valves, fittings, and manholes), profiles of streets, sanitary sewer mains and storm drainage mains, details of special or unusual installations, and detention pond volumes. The Designer shall GPS all points, including manholes, valves, inlets, and other pertinent infrastructure and provide the GPS data on Record Drawings. If significant corrections to the improvements are noted during the acceptance inspection, the Record Drawings may be returned to the Developer or Designer for revisions. The final submittal shall have each sheet of the Record Drawings signed and sealed by the Professional Engineer (PE) registered in the State of Colorado who is responsible for preparing the Record Drawings.

13.3.6 Certification of Storm Drainage Detention , Including Roadways

A land surveyor registered in the State of Colorado shall affirm the as-built detention pond volumes and surface areas at the design depths, outlet structure sizes and elevations, storm drainage sizes and invert elevations at inlets, manholes, discharge location, representative open-channel cross-sections, and dimensions of all drainage structures.

13.3.6.1 Certification

Roadway grades shall be considered part of the storm drainage system. Storm detention and permanent storm water quality Control Measures (best management practices [BMPs]) facilities must be certified after final landscaping is implemented. This certification is required before a certificate of occupancy will be issued for any private development or redevelopment, or before final payment on any public improvement project. A PE licensed in the State of Colorado shall certify the following:

- The detention pond and all permanent storm water quality Control Measures (BMPs) are built according to the approved plans and specifications.
- The required detention volume is met by the completed facilities.
- The surveyed elevations of critical design components, including inverts, of outlet structures geometry, overflow spillways or weirs, and freeboard reflect the final constructed values; the finished pond depths, storage volumes, and release rates are in substantial conformance with the approved design; and actual release rates conform to applicable regulatory agency rules and regulations Colorado Revised Statutes. The certification shall include a copy of the City's plan acceptance letter to assist City staff in their review of the certificate. Detention ponds used as sedimentation basins through a phased construction development shall also be required to have the detention facilities recertified prior to each phase of the development's final certificate of occupancy.

13.3.6.2 Standard Note

The following note shall appear next to each detention pond plan and permanent storm water quality BMP on the construction drawings:

> "The developer shall have a Colorado licensed Professional Engineer certify each stormwater detention pond and/or water quality Control Measure is built according to the approved plans and specifications and the required detention volume, including the WQCV when used, is met. The certification shall also verify all pertinent dimensions, elevations, required outlet orifice plates for detention and WQCV and other permanent Control Measure requirements are installed per the approved plans and specifications, and shall show the as-built volumes for the 100-year and 10-year storm events, and for the WQCV and other pertinent dimensions, elevations and capacity requirements associated with the water quality Control Measure used. The certification shall be provided to the City of Castle Pines before a certificate of occupancy will be issued, or before final payment on public improvement projects."

13.3.6.3 Maintenance

The maintenance of permanent storm water facilities shall be performed by the property owner, or as otherwise designated by legal agreement. Maintenance operations shall be in accordance with the approved O&M manual for the project. Routine maintenance of permanent stormwater facilities shall include sediment and debris removal. Nonroutine maintenance may include the repair or replacement (or both) of outlet structures, trickle channel, outlet pipes, channel slopes, and other related facilities. When appropriate maintenance is not provided, the City may provide the necessary maintenance and shall assess the associated cost to the property owner. All permanent stormwater facilities, with or without retaining walls, shall be designed in accordance with the maintenance requirements as specified in the Mile High Flood District's Urban Storm Drainage Criteria Manual.

13.3.6.4 Storm System Improvements

The storm system improvements are evaluated after the submittal of the storm drainage plan and the drainage report.

- Maintenance: Permanent stormwater facilities must be properly maintained if they are to function as intended over a long period of time. The following types of maintenance tasks should be performed periodically so that permanent storm water facilities function properly:
  - Inspections: Permanent storm water facilities must continue to be inspected under the GESC Permit until final stabilization is achieved, the GESC Permit is closed, and the City has accepted the permanent storm water facilities as a Final Acceptance. After this occurs, the facility must be inspected on an annual basis. In addition, the City recommends that these facilities be inspected during and after major storm events to confirm that the inlet and outlet structures are still functioning as designed, and that no damage or clogging has occurred.
  - Mowing: Impoundments should be mowed at least twice a year to discourage woody growth and to control weeds.
  - Sediment, Debris and Litter Control: Accumulated sediment, debris, and litter should be removed from permanent storm water facilities at least twice a year. Particular attention should be given to removal of sediment, debris, and trash around outlet structures to prevent clogging of the control device.
  - Nuisance Control: Standing water or soggy conditions within the lower stage of permanent storm water facilities can create nuisance conditions such as odors, insects, and weeds. Allowance for

positive drainage during design will minimize these problems. Additional control can be provided by periodic inspection and debris removal, and by verifying that outlet structures are kept free of debris and trash.

- Structural Repairs and Replacement: Inlet and outlet devices, and standpipe or riser structures have been known to deteriorate with time and may have to be replaced. The actual life of a structural component will depend on individual site-specific criteria, such as soil conditions.
- Maintenance should be done as described in the Operations and Maintenance (O&M) Plan. O&M Plans are required to be submitted to the City.

13.3.6.5 Colorado Registered Professional Engineer

The responsible Designer shall state the following: "I have inspected the drainage facilities and to the best of my knowledge, belief, and opinion, the drainage facilities were constructed in accordance with the design intent of the approved drainage report and construction drawings."

13.3.7 Written Notice of Initial Acceptance

Upon completion of all items on the deficiencies list and payment of all outstanding fees, reimbursements, and other items owed to the City, the City Public Works Department will issue a written Initial Acceptance of the Public Improvements and start the warranty period. No Initial Acceptance will be issued unless all public improvements required on plans and in the SIA or relevant agreement are complete and accepted, including detached walk.

The City shall hold the specific surety percentage as defined in the site agreement after Initial Acceptance and prior to the 2-year warranty period.

13.3.8 Warranty Period

The City requires a minimum 2-year warranty.

13.3.9 Inspection Prior to End of Warranty Period

After the Developer or Contractor has submitted a written request for Final Acceptance, a new deficiency list shall be developed by, and provided to, the Developer or Contractor for appropriate replacement or repair.

13.3.10 Written Notification of Release and Final Acceptance

When the warranty period is concluded, and all defects in workmanship or material are completed, the City will issue a Final Acceptance Letter to the Developer or Contractor.

13.3.11 Release of Surety and Contractor Responsibilities

With the completion of all deficiency lists, appropriate notifications, and inspections, the surety will be released signifying all responsibility of the Developer or Contractor for repairs and maintenance is completed.

13.4 Initial Acceptance

13.4.1 Request a Preliminary Walk-through Acceptance

Once improvements (streets or drainage) that are covered by a valid City permit, designed in the accepted construction plans, and detailed in the SIA, development agreement, or approved plans are constructed to City standards, the Owner or Developer shall request in writing a Preliminary Walk-through Acceptance inspection for an entire phase or multiple phases.

13.4.2 Request for Warranty Acceptance

After the Preliminary Walk-through Acceptance has been completed and any deficiencies repaired, the Owner or Developer shall submit a completed and signed "Request for Warranty Acceptance" form to the City's Public Works Director requesting Initial Acceptance. The request shall acknowledge that the Owner or Developer has fulfilled the subdivision improvement agreement requirements on the extent of public improvements. The request shall be accompanied by a Vicinity Map, which should show access to the filing or phase from the nearest arterial roadway. The roads included in the request must be highlighted on the map, and street names must be legible. The Applicant's Developer or Engineer shall provide a map of the phasing to be reviewed.

13.4.3 Phasing

It is the City's practice to accept all the improvements for a subdivision at one time or by completed phases (phases shall be shown on all construction drawings to confirm complete loops in each phase). If the Owner or Developer desires partial acceptance of subdivision public improvements, a request for such partial acceptance should precede the request. The partial acceptance request should define and justify the partial acceptance schedule and explain the circumstances of the partial acceptance request. Such requests shall be considered by the City Public Works Department on a case-by-case basis. The developer shall submit a partial acceptance letter. The City will require the security to be changed and divided by each partial phase.

13.4.4 Independent Test Verification

Included with the acceptance request shall be independent test verification by a registered PE. Such verification shall consist of acceptable destructive or nondestructive tests. The frequency and results need to conform to City requirements. An evaluation report based on those tests is required to substantiate compliance with the accepted plans and that the expected life of the roadway structure is at least 20 years, based on normal surface maintenance being provided by the City.

13.4.5 Consideration of Exceptions

If the Applicant's engineer cannot verify substantial compliance with the accepted construction plans, a list of changes or exceptions to the plans shall be provided for consideration of acceptance by the City's Public Works Director. These must be documented by submitting record drawings with the list of changes or exceptions.

13.4.6 Profilograph

Included with the acceptance request shall be a profilograph of all Arterial and Collector roadways constructed with the project. Profilograph tests shall be made for each driving lane.

13.4.7 Developer Responsibilities

Until Final Acceptance by the City of the subdivision improvements, the Developer shall, at the Developer's expense, make all needed repairs or replacements to the subdivision improvements required on account of defects in materials or workmanship and shall be responsible for ordinary repairs and maintenance thereof, including street sanding, snow removal, and cleaning. Subsequent to Initial Acceptance and subject to accessibility, the City may elect to relieve the Developer of traffic signage and snow removal responsibility.

1) Traffic control devices, either temporary or permanent, as accepted on the construction plans, must be installed before the City will accept the improvements.
2) The City will not be responsible for installation or maintenance of any barricades or warning signs required to protect the public as a result of construction phasing.
3) During the warranty period, the Developer shall be responsible for all corrective or preventative maintenance as requested by the City in writing, so that all improvements are in-place for as much of the preliminary warranty period as possible. Such maintenance shall commence within 30 calendar days after receipt of said written request (weather permitting).

13.4.8 Acceptance Inspection

Upon completion of each phase of improvements, the Owner or Developer shall request Preliminary Walk-through Acceptance of the completed public improvements. The City will inspect the improvements within 10 working days after request, and if the improvements are in substantial compliance with the accepted plans, accept such improvements. The Owner or Developer shall be responsible for assuring that all the improvements are in good repair and are generally in an acceptable condition for a thorough visual inspection. If improvements are deemed by the City not to be in acceptable condition for a visual inspection, the Owner or Developer shall request an additional inspection within 10 working days. After 10 days, the City will require additional payment for the added inspection requirements.

Any changes to the inspection date requested by the Owner or Developer shall be received no less than 3 working days prior to a scheduled inspection. Notice may be written or verbal.

13.4.9 Notification of Deficiencies

At the time of or within 10 working days following an acceptance inspection, the Owner or Developer shall provide the City with a written list of deficiencies (punch list) for the improvements. The City will review the punch list and confirm accuracy. These punch list items must be rectified by the Owner or Developer as a condition of the City's granting Initial Acceptance. The Owner or Developer shall obtain the necessary Permits prior to commencing the remedial work. The first Permit for punch list items will be issued at no cost and be valid for 60 calendar days. In the event the punch list items are not complete within 60 calendar days, an additional Permit(s) will be required to be purchased at the current minimum fee or the normal cost of remaining items to be constructed (whichever is greater) according to the current City Fee Schedule. If the Owner or Developer wishes to request weather days during this 60-calendar-day period, they will provide the City Public Works Department with a written request, including justifications as to why weather days are required. The City's Public Works Director has the sole authority to allow or disallow weather days during this period.

13.4.10 Reinspections

When the Owner or Developer completes the repairs according to the deficiency list previously provided, a reinspection shall be scheduled through the City Public Works Department. If inadequate repairs are observed or site conditions do not allow a visual inspection, the City may terminate the reinspection, at which point the Owner or Developer shall take corrective measures to address the City's comments and reschedule a new reinspection.

13.4.11 Recommendation for Initial Acceptance

The City Inspector shall recommend granting or denying Initial Acceptance based on reinspection for compliance to the written deficiency list, previously provided to the Developer or Contractor.

13.4.12 Initial Acceptance Letter

The City Public Works Department shall issue a letter to the Developer or Contractor within 10 days of acceptance reinspection. The Initial Acceptance letter shall specify the date on which the Contractor is eligible to request Final Acceptance. Because of potential non-conformance issues, such as as-built elevation discrepancies, the release of building Permits will be on the "at-risk" basis of the Builder until the Developer or Contractor has achieved Initial Acceptance.

13.4.13 Adjustment of Collateral

Upon written notification of Initial Acceptance, the collateral for Public Improvements in Development projects may be reduced to the percentage required by the City during the warranty period of the total required collateral for the project.

13.4.14 Acceptance Denied

If acceptance is denied, deficiencies shall be explicitly delineated for the Owner or Developer to remedy and schedule a reinspection.

13.4.15 Denial of Initial Acceptance

A request for Initial Acceptance of subdivision improvements for which such acceptance has been previously denied by the City shall be treated as a new request for acceptance.

13.4.16 Adjustment of Retainage for Contractor

Upon written notification of substantial completion, the retainage for the project may be reduced to the percentage acceptable to the City and in accordance with the specific contract.

13.5 Warranty Period

13.5.1 Duration

All public improvements shall be subject to a warranty period of at least 2 years after the date of the letter of Initial Acceptance from the City Public Works Department. It starts at Initial Acceptance and ends with the Final Acceptance of the Public Improvements. If the Developer or Contractor requests and is granted an extension to repair deficiencies, the surety and deficiencies list will remain in place for that additional period of time.

13.5.2 Maintenance Responsibility

The Developer or Contractor shall be responsible for the maintenance of all public improvements, in accordance with the contract, during the warranty period. The City Public Works Department will notify the Developer or Contractor of any maintenance that may be necessary during this time. Routine maintenance normally performed by the Developer or Contractor includes, but shall not be limited to, cleaning streets, snow removal, patching potholes, and removing blockages from water, storm, and sanitary sewer facilities. The cost of any routine maintenance not performed by the Developer that must be performed by the City will be billed to the Developer at cost plus 15% and, if applicable, the requirements of the SIA or relevant agreement. If the Developer does not pay for these costs within 60 days, the City may pull the surety to recover costs.

13.5.3 Emergency Repairs

In the event of a water main break, sanitary sewer main blockage, street or bridge failure, or other emergency that may occur during the warranty period, it may become necessary for the City to undertake immediate repairs to the facilities and make the area safe to residents, pedestrians, or motorists. The City will attempt to contact the Developer or Contractor in the event of such emergency. However, if the Developer or their representative cannot be contacted quickly, or if the Developer or Contractor is unable to take immediate action to relieve the urgent situation, the City may proceed with such action as deemed necessary by the City Public Works Department, and the Developer or Contractor will be billed for all costs of these actions at cost plus 15%.

13.6 Final Acceptance of Public Improvements

13.6.1 Request for Preliminary Inspection

No sooner than 60 days prior to the completion of the 2-year or other warranty period within a phase or phases of the project, the Owner or Developer shall make a written request with the City Public Works Department for a site inspection. The Owner or Developer is responsible for having the public improvements clean and free of debris at the time of the inspection. Failure to do so shall require rescheduling the inspection. Rescheduling will be treated as a new inspection, not a reinspection.

13.6.2 Punch List

During the field inspection, a punch list of items requiring remedial action will be prepared. The punch list shall be issued to the City by the Owner or Developer within 10 working days of completing the inspection.

13.6.3 Permits

The Owner or Developer shall obtain the necessary Permits prior to commencing the remedial work. The first Permit for punch list items will be issued at no cost and will be valid for 60 days. In the event the punch list items are not complete within 60 days, an additional Permit(s) will be required.

13.6.4 Final Inspection Request

Upon completion of all remedial work, the Owner or Developer shall request a Final Inspection with the City Public Works Department.

13.6.5 Request for Full-Term Maintenance

Upon satisfactory completion of the Final Inspection and the 2-year warranty period, as outlined in the Initial Acceptance Process, the Owner or Developer shall submit a completed and signed “Request for

Final Acceptance" form to the City Public Works Department requesting Final Acceptance. A City Public Works Department representative shall accept the request for Full-Term Maintenance within 10 working days.

13.6.6 Release Warranty Security

Once Final Acceptance has been obtained by the Owner or Developer of any phase or phases of the project, any warranty security held by the City for said phase or phases will be released to the Owner or Developer.

13.6.7 Winter Work

In the event of a winter Final Acceptance date, it would be acceptable to the City to make a request to the City Public Works Department for inspection of any phase or phases of a project earlier than 90 days prior to the expiration date of the 2-year warranty period. Each request will be considered by the City Public Works Department on a case-by-case basis.

13.6.8 Acceptance of Roadways by a Special District or Other Quasigovernmental Agency to Be Accepted by the City of Castle Pines

When a District or Agency constructs a roadway, the City will require both the Preliminary and Final Acceptance walk-throughs, the execution of the punch lists, and the completion of all repairs before the end of the 2-year warranty period. This will allow repairs and corrections to the construction (as specified in these Roadway Standards) to take place before the performance bond is released to the contractor by the District or Agency.

13.6.9 Preparation of Corrections List

The City Public Works Department will be contacted to schedule and perform an inspection of the public improvements within the project limits. The Developer, or their representative, or Contractor will be invited to accompany the City's representative on all such inspections. The Owner or Developer shall provide the punch list of repairs and deficiencies and deliver the list to the City to confirm accuracy. The City will provide an opportunity for an optional meeting to discuss issues. The condition of the public improvements will be inspected for conformance with the accepted plans, the Official Development Plan (if applicable), the Public Improvements Agreement (if applicable), these Roadway Standards, and Municipal Code. If the inspection cannot be performed as a result of excessive dirt or snow on streets, poor weather conditions, inaccessibility, or other reasons, the Developer or Contractor will be notified of the need to postpone these activities until the cause of the delay can be rectified.

13.6.10 Correction of Deficiencies

Warranty correction list items should be corrected within 2 months of the date of the warranty correction list, unless authorized by the City Public Works Department. If all noted deficiencies are not corrected within this time, the public improvements may be reinspected, a revised correction list may be issued, and the end of the warranty period may be adjusted at the discretion of the City Public Works Department to allow ample time for the corrections to be completed. The end of the warranty period will not be acknowledged until all noted deficiencies are corrected within the proper time frame. The appropriate Engineering Construction Inspector shall be notified before any corrective work commences and immediately upon the completion of the repairs.

13.6.11 Written Acknowledgment of End of Warranty

Upon completion of the correction of all deficiencies noted in the warranty correction list, the City Public Works Department will issue a written acknowledgment of the end of the warranty period for the public improvements. Surety or warranty bond for public improvements may be released in its entirety at this time.

13.7 Acceptance/Warranty Inspection Criteria

13.7.1 General

All public and private improvements shall be installed in conformance with the approved Public Improvements Construction plans, the Official Development Plan (if applicable), the Public Improvements Agreement (if applicable), construction agreement (if applicable), and these Roadway Standards. The City Public Works Department shall be the final authority in the determination of defects and required corrections to public and private improvements. The following lists of items is not necessarily the entire list of items to be checked in the inspection process.

13.7.2 Grading and Seeding

Finished grades shall conform with the approved plans and the official Development Plan. Detention pond grading shall provide, at a minimum, the required volume as defined in the approved final drainage study. Unless otherwise approved, no slopes shall exceed a grade of 4 (horizontal) to 1 (vertical) (4:1). Approved seed mix shall be applied (unless other landscape improvement materials are approved), and grass shall be established in conformance with *Earthwork and Erosion Control* and *Revegetation and Seeding* in the GESC Standards

13.7.3 Water Systems

The required inspection and testing of sanitary sewer mains and appurtenances (including backfill) shall be performed and accepted prior to the installation of the roadway, curb, sidewalk, trails, traffic infrastructure, and storm drainage. Refer to the requirements of the appropriate Water or Sanitary Sewer District. Separately, the City shall require the Developer or Contractor to submit the plan and profile sheets (electronically) with the mapping of all compaction test locations and results for the City review to confirm compliance with the frequency of testing requirements and the sufficiency of those tests. The City is not responsible for reviewing test frequency or conformance to Standards prior to Initial or Final Acceptance.

13.7.4 Sanitary Sewer Systems

The required inspection and testing of sanitary sewer mains and appurtenances shall be performed before the installation of surface public improvements (including roadway, curb, sidewalk, trails, traffic infrastructure, and storm drainage). Refer to the requirements of the appropriate Water or Sanitary Sewer District. Separately, the City shall require the Developer or Contractor to submit the plan and profile sheets (electronically) with the mapping of all compaction test locations and results for the City review to confirm compliance with the frequency of testing requirements and the sufficiency of those tests. The City is not responsible for reviewing test frequency or conformance to Standards prior to Initial or Final Acceptance.

13.7.5 Storm Drainage System

The required inspection and testing of storm drainage mains and appurtenances that shall be performed are outlined in the *Storm Drainage & Other Concrete Facilities* section of the City's Drainage Standards The City shall require the Developer or Contractor to submit the plan and profile sheets (electronically) with the mapping of all compaction test locations and results for the City review to confirm compliance

with the frequency of testing requirements and the sufficiency of those tests. The City is not responsible for reviewing test frequency or conformance to Standards prior to Initial or Final Acceptance.

At the time of acceptance and warranty inspections of all public improvements, additional aspects of storm drainage system construction that shall be inspected include, but shall not be limited to, the following:

- All pipes and manholes shall be free of construction debris, dirt, trash, and other foreign material.
- The Contractor's video inspection of all storm drainage mains shall be completed prior to the acceptance of public and private improvements.
- Manholes rims and covers shall be adjusted to within one-fourth inch below grade in paved areas, or 1 inch above grade in landscaped areas.
- Manhole steps shall be properly spaced and aligned.
- Inlets shall be properly aligned to within one-eight inch below grade next to sidewalk or curb and gutter.

13.7.6 Concrete

The required inspection and testing of concrete that shall be performed is outlined in Chapter 12, Inspection and Testing Procedures, of these Roadway Standards. At the time of acceptance and warranty inspection of all public improvements , the aspects of concrete construction that shall be inspected include, but shall not be limited to , the following:

- Breakage or cracking greater than 1/32 of an inch at locations other than construction joints
- Ponding of any size
- Settlement affecting drainage, pedestrian, or traffic safety
- Surface spalling or deterioration
- Longitudinal cracking
- Subsurface settlement

13.7.7 Roadway Inspection Criteria

The required inspection and testing of roadways that shall be performed is outlined in Chapter 12, Inspection and Testing Procedures, of these Roadway Standards. At the time of acceptance and warranty inspection of all public improvements, the aspects of roadway construction that shall be inspected include, but shall not be limited to, the following:

- Breakage or cracking greater than one-eighth inch
- Ponding of any size
- Settlement affecting drainage, pedestrian, or traffic safety
- Surface segregation of fines or aggregate
- Hazardous conditions
- Alligator cracking
- Improper grade or inverted crown
- Subsurface settlement

13.8 Record Drawing Criteria

Record Drawings shall be submitted to the City Public Works Department for all improvements constructed under the terms of the SIA, SIPIA, SIA-Private, or under the conditions specified by the Planning Commission or City Council in accepting any other land use changes, or under the terms of a Service Plan and accepted construction plan for a Metropolitan Improvement District.

13.8.1 Other Requirements

Record Drawings must accompany the request for Initial Acceptance of the constructed public or private improvements.

13.8.2 City Records

Record Drawings shall consist of full-size, electronic marked-up City of Castle Pines accepted plans with the Registered Colorado PE's signed and stamped certification note and the Registered Colorado Professional Land Surveyor certification.

13.8.3 Engineer and Surveyor Statement Requirements

Engineer's and Surveyor's Statements of Substantial Compliance of the Record drawings is required on the cover sheet only and as follows:

1) Registered Colorado Professional Engineer: The responsible PE for the project shall state the following: "Based upon review of, and reliance on, the field survey data and other pertinent data provided by (Name of Firm(s) or Surveyor), on (Date), and a final site investigation conducted on (Date), I hereby state that to the best of my knowledge, information, and belief, it is my professional opinion that the facilities shown in these drawings were constructed in substantial compliance with the accepted Drainage Report and/or Construction Drawings and the Engineer's intent. This statement is based only on a review of the field survey data and a final site investigation."
2) Registered Colorado Professional Land Surveyor: A registered land surveyor in the State of Colorado shall certify the record of permanent stormwater facilities volumes at the design depths, outlet structure sizes and elevations, storm sewer sizes and invert elevations at inlets, manholes and discharge locations, representative open-channel cross-sections, and dimensions of all the drainage structures. The surveyor shall also state the following: "A Record Drawing field survey was conducted by (Surveyor), on (Dates). All items noted on these drawings with an "RD" indicate Record Drawing information based on said survey. Unless explicitly marked with an "RD," constructed condition should not be assumed. I, (Surveyor), hereby state that in my professional opinion, the Record Drawing information shown on these plans accurately represents the improvements constructed."

13.8.4 City Review

The City Public Works Department staff will compare the certified Record Drawing information with the accepted construction drawings. Acceptance for the public improvements will be issued only if the following occurs:

1) The Record Drawing information demonstrates that the construction complies with the design intent.
2) The Record Drawings are certified by both a Registered Colorado PE and a Registered Colorado Professional Land Surveyor.

13.8.5 Record Drawing Data Requirements

Record Drawings shall show the following Information:

1) Record Drawings for roadways shall verify centerline and flowline location and elevation at high points, low points, vertical grade breaks and curves, all points of horizontal curvature, curb returns, surface utilities and structures, right-of-way monuments and curb ramp locations.
2) Record Drawings for storm sewers shall verify the size and elevation of all pipes (including pipe class), inlets, riprap, headwalls, and all other storm drainage infrastructure shown on the accepted plans, including those improvements located in areas outside of public rights-of-way.
3) Record Drawings for open channels shall verify all drainageway grades and channel shape, horizontal and vertical information for grade control structures and stabilization measures, storm sewer outfalls if not shown on the storm sewer Record Drawings, and maintenance access.
4) Record Drawings for permanent storm water facilities shall verify horizontal and vertical information of all facilities, including locations of low-flow or trickle channels, outlet structure, emergency overflow spillway, pipe or channel inlets, water surface limits, and maintenance access.
5) Record Drawings for permanent storm water facilities shall verify horizontal and vertical information of the facility, water surface limits, and maintenance access.
6) Record Drawings for Signage and Striping Plan sheets shall verify the type, size, and location of all signage and striping shown on the accepted plans.
7) Record Drawings for Traffic Signal Plan sheets shall verify the type, size, and location of all traffic signal devices shown on the accepted plans.
8) Record Drawings for Landscape Plan sheets shall verify locations of trees, monuments, planters, drainage improvements, and trench drains shown on the accepted plans.
9) Record Drawings shall verify other information as specifically requested by the City Public Works Department, and as identified on the accepted plans.

13.8.6 Electronic Record information

1) The Engineer shall submit electronic record information of all pipes, manholes, inlets, riprap pads, headwalls, and all other storm drainage infrastructure, including inverts shown on the accepted plans, including those improvements located in areas outside of public rights-of-way, to the City in "DWG" or "DXF" format prior to receiving Initial Acceptance.
2) The City reserves the right to request additional electronic record information in DWG and GIS formats. The City will provide the Owner or Developer a written request for additional electronic Record information, including preferred formats, prior to initial acceptance.
3) All electronic record information shall be provided with the corresponding survey control data.

Appendix A
Roadway Design and Construction Standards – Standard Drawings

Appendix A. Roadway Design and Construction Standards – Standard Drawings

MEDIAN COVER MATERIAL	SD.15
MEDIAN NOSE DETAIL	SD.16
CONCRETE JOINTS	SD.17
CONCRETE JOINTS	SD.18
TYPICAL CONCRETE JOINT LAYOUT	SD.19a, SD.19b, SD.19c, SD.19d
CURB INLET - TYPE R (5', 10' OR 15' IN LENGTH)	SD.20a, SD.20b, SD.20c, SD.20d
INLET - TYPE C	SD.21a, SD.21b, SD.21c
INLET - TYPE D	SD.22a, SD.22b, SD.22c
GRATED INLET TYPE 13	SD.23a, SD.23b
DENVER TYPE 16 – SINGLE NO. 16 INLET	SD.24a, SD.24b
DENVER TYPE 16 – DOUBLE NO. 16 INLET	SD.25a, SD.25b
DENVER TYPE 16 – TRIPLE NO. 16 INLET	SD.26a, SD.26b
DENVER TYPE 16 – SINGLE, DOUBLE & TRIPLE NO. 16 INLET VALLEY	SD.27a, SD.28b
DENVER – GRATE & FRAME AND ADJUSTABLE CURB BOX	SD.28a, SD.28b
MANHOLES	SD.29a, SD.29b, SD.29c, SD.29d, SD.29e, SD.29f, SD.29g
DENVER – TYPE "P" MANHOLE	SD.30a, SD.30b,
DENVER-TYPE P MANHOLE, TOP SLAB AND DETAILS	SD.31a, SD.31b
DENVER – MANHOLE AND INLET STEPS	SD.32
PIPE INSTALLATION IN TRENCH	SD.33a, SD.33b
PIPE INSTALLATION IN TRENCH FOR STREET CUT	SD.34a, SD.34b
PIPE CONNECTION DETAIL	SD.35a, SD.35b

ROADSIDE DITCH SECTION	SD.36
URBAN ROADSIDE SWALE	SD.37
HEADWALLS FOR PIPE CULVERTS	SD.38a, SD.38b
WINGWALLS	SD.39a, SD.39b, SD.39c, SD.39d, SD.39e
CONCRETE OR METAL END SECTIONS	SD.40a, SD.40b
TRAVERSABLE END SECTIONS AND SAFETY GRATES	SD.41a, SD.41b, SD.41c, SD.41d, SD.41e, SD.41f
RESIDENTIAL SIDEWALK CURB CHASE	SD.42a, SD.42b
RANGE BOX	SD.43
MAILBOX SUPPORT	SD.44a, SD.44b
EMERGENCY OVERFLOW CHANNEL (IN DRAINAGE TRACT)	SD.45
CURB TRANSITION TO DITCH	SD.46
CURB CUT	SD.47
ASPHALT STREET CUT/ PATCHING	SD.48
TEMPORARY STEEL PLATE	SD.49
SIDEWALK CHASE DRAIN	SD.50a, SD.50b, SD.50c
TYPICAL SIGN PLACEMENT DETAIL	SS.1
STREET NAME SIGN ASSEMBLY	SS.2
GROUND MOUNTED STREET NAME SIGN DETAIL	SS.3
TYPICAL LOCATIONS FOR STOP SIGNS AND YIELD SIGNS	SS.4
TYPICAL 'NO OUTLET' AND 'DEAD END' SIGN PLACEMENT	SS.5